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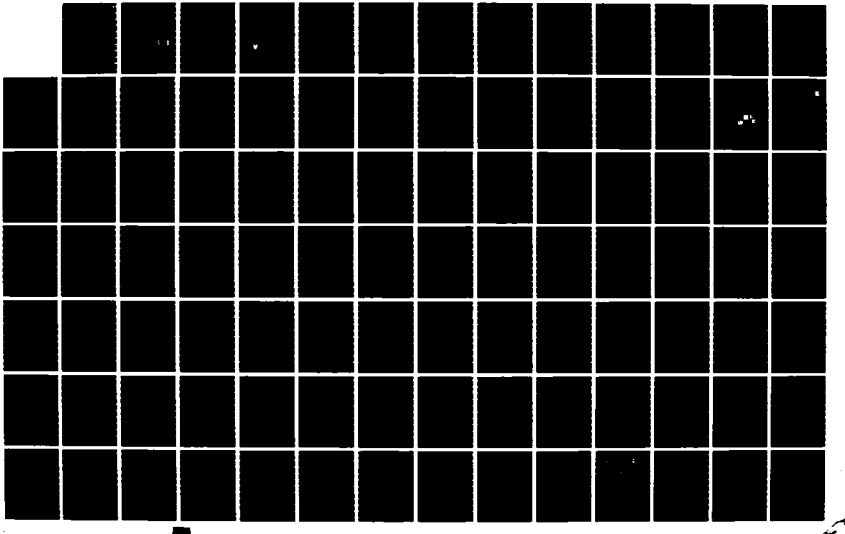

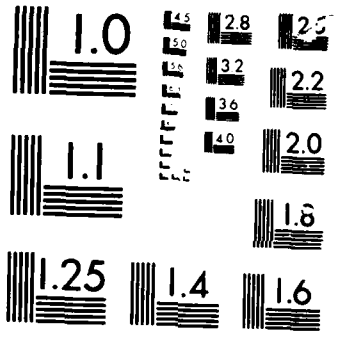

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A PROTOTYPE MAINTENANCE EXPERT SYSTEM FOR THE CH-47 FLIGHT CONTROL HYDRAULIC SYSTEM

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ABSTRACT

An investigation of the hydraulic flight control system of a Boeing CH-47 Chinook helicopter utilizing artificial intelligence techniques will be undertaken. Specifically, a *knowledge based expert system* will employ situation-action rules (production rules) to diagnose a failure and subsequently identify specific device(s) which caused that failure. Moreover, because the behavior of the system is directly responsive to the goals the system is attempting to achieve, the expert system's inference engine performs a backward-chaining process via a goal-driven control strategy. This strategy involves finding rules that demonstrate the hypothesis and then verifying the facts that enable the rule to work. The *List Processing Language* (*LISP*) is used to facilitate data processing and symbolic logic expression manipulation.

ACKNOWLEDGMENTS

Many thanks to Dave Handleman for his assistance throughout the term. He is the author of the expert system's inference engine. Thanks also go to Professor Robert Stengel for his guidance. Above all, I would like to thank my parents for their constant encouragement and help throughout my four years at Princeton.

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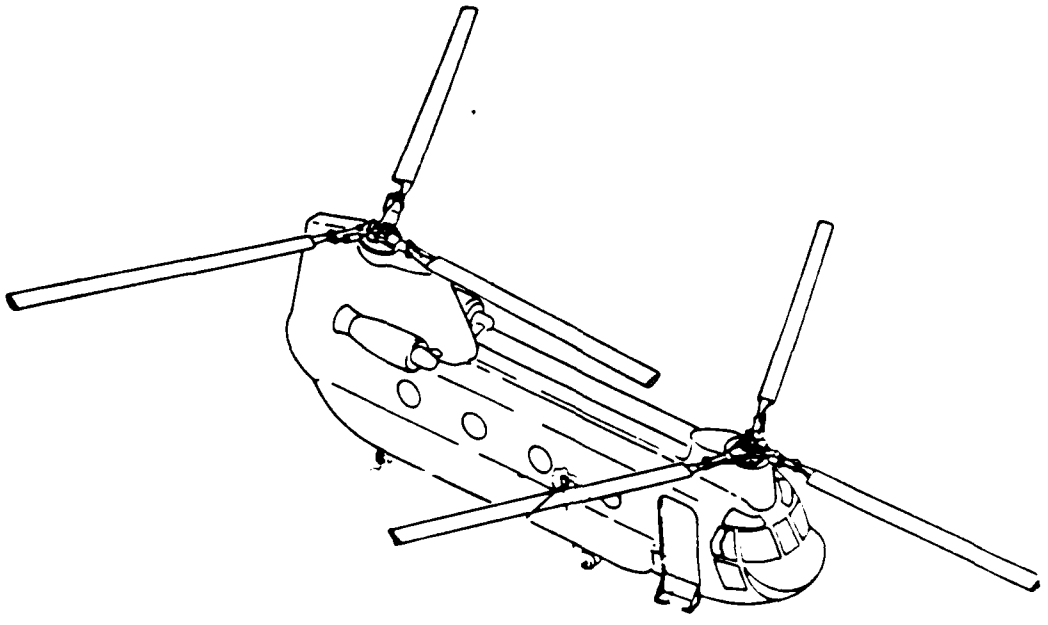
LIST OF FIGURES

GENERAL BACKGROUND

The CH-47 Chinook twin-rotor helicopter is an exceedingly complex flying machine. See *FIGURE 1*. As in any complicated apparatus, failures must be detected immediately and implementation of corrective procedures must be performed quickly, especially when human life is at stake. The project's present goal is to provide an interactive system which can detect failures and propose possible diagnostics for the flight control hydraulic system. Aspects of Artificial Intelligence (AI) relating to expert systems are implemented. The AI field is relatively new with regard to implementation of expert systems for failure diagnosis of complicated systems. Hence, this research should prove not only interesting because of its "cutting edge" nature in the AI field, but also useful in its practical applications for efficient and effective failure detection and diagnosis.



CHINOOK CH-47 HELICOPTER
FIGURE 1

EVOLUTION OF ARTIFICIAL INTELLIGENCE

AI originated in the 1950's through the efforts of several computer scientists investigating new methodologies to solve old problems through symbolic programs. Results in automated deduction and problem-solving produced great enthusiasm. During the last two decades, AI researchers have recognized the value of domain specific knowledge as a basis for solving significant problems [1]. However, at the same time, researchers also have realized that generic problem-solving strategies by themselves cannot solve the world's most challenging problems. To solve a problem in the field of engineering, finance, or medicine, for example, machine problem-solvers found it necessary to understand human problem-solvers way of thinking about a particular subject. The computer offers many advantages over the human mind -- such as speed and consistency -- but it lacks the ability to compensate for ignorance [1].

In short, AI researchers concluded that high IQ does not necessarily make a person an expert, but specialized knowledge does. For a fast and consistent symbol processor to perform as effectively as a human expert, the machine must possess the specialized knowledge and reasoning capabilities that is inherent in a human expert. This need evolved into the field of knowledge engineering and resulted in the growth of *expert systems*.

ROLE OF EXPERT SYSTEMS

Expert systems are intelligent computer applications that use data, a knowledge base, and a control mechanism to solve problems of sufficient difficulty in which significant human expertise is necessary for solution. These systems use AI problem-solving and knowledge representation techniques to combine human expert knowledge concerning a problem area with human expert methods of conceptualizing and reasoning about that problem area [2]. Therefore, such a system can achieve the human expert's level of performance in a specialized problem area. The factual knowledge domain possessed by the expert system is real, but the knowledge for diagnosis is artificially generated. The high-level knowledge base and its associated control mechanism are essentially the expert's *knowledge and reasoning capabilities coded via a* high-level programming language.

Expert systems cannot replace the human being, but they can provide substantial support. Two types of expert systems are available: diagnostic and pedagogic. The first type is application oriented and its goal is to assist the user to resolve specific problems in particular fields. The pedagogic type of expert systems is concerned with how specific knowledge or information should be taught. The expert system developed in this case is of the diagnostic type.

KNOWLEDGE BASE

Knowledge bases are different from data bases in several ways. A knowledge base is an unstructured set of facts. Paths by which facts are related are determined "on the fly" as needed to solve particular problems. The bulk of the information in the knowledge base is inferred from a few basic facts. A data base incorporates a predetermined structure of facts. The relationships between data items in the data base are designed in advance. All information is stored explicitly.

The most prevalent technique used in organizing knowledge bases is to form production rules, which become connected to one another by *if-then* statements that build rule networks. Rules in the knowledge base represent both facts and heuristics -- facts being discrete pieces of information that are generally accepted and heuristics being rules of thumb that characterize expert-level decision making in the problem area. Both facts and heuristics are generated throughout the session directly resulting from system inferences and user intervention.

INFERENCE ENGINE

The expert system's control structure or inference engine makes decisions concerning the use of the system's knowledge by organizing and controlling the steps needed to solve current problems. The control mechanism is actually a collection of procedures or strategies whose function is to solve problems. Two search techniques generally employed are backtracking and graph-searching. Backtracking uses pro-

cedures which explore one path as far as possible. If the path search reaches a dead end or determines that a goal can be reached, the procedure then backtracks to previous states and chooses another path in a different direction. The goal is to search all paths and determine the outcome of such searches. The procedures are written recursively to avoid redundancy and complexity of code [3]. Graph-searching explores several paths simultaneously while maintaining concurrently the status of several states of the system. Either some paths may be explored faster or a breadth first search may be employed in which all paths are searched at the same speed.

A common but powerful problem-solving mode of rule based systems involves the chaining together of if-then rules to form a line of reasoning. Subsets of the search techniques mentioned previously are available: forward and backward chaining. Forward chaining employs knowledge base rules on some initial state or condition of the data and continually applies rules to new conditions until the desired goal is attained.

This project implements the technique of backtracking while employing a backward-chaining search which has had proven success in systems for diagnosis and planning. In backward chaining, the conclusion is assumed but the path to it is not, as in the case of goals and hypotheses. These rules work from goals to subgoals by using the action side of rules to deduce the condition of rules. Specifically, the control mechanism scans the rule base to find those rules whose consequent actions can achieve the desired goal. Each of these rules is tried in suc-

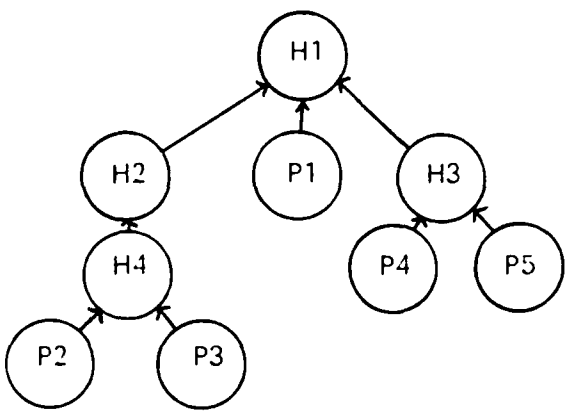
cession. If the antecedent side of the rule correlates to the existing conditions in the working memory (coined by J. McDermott in "*R1: An Expert in Computer Systems Domain*") [4], then the rule is fired and the subgoal is achieved. However, if an unmatched antecedent is encountered, that antecedent becomes a new subgoal, and the same procedure is applied recursively. If no rules establish that subgoal, the system prompts the user for additional information.

Without the appropriate heuristics for guidance, backward-chaining will encounter problems in handling conjunctive subgoals [2]. In general, this requires finding a case where all interacting subgoals are satisfied, a search that in the worst case could result in an overload of information. Thus, in addition to appropriate heuristics, suitable inferences and architectures must be found for each type of problem area in order to achieve an efficient and effective expert system.

As an example, the following illustration concisely depicts the basic structure of a knowledge based system [4].

H = hypothesis

P = proof

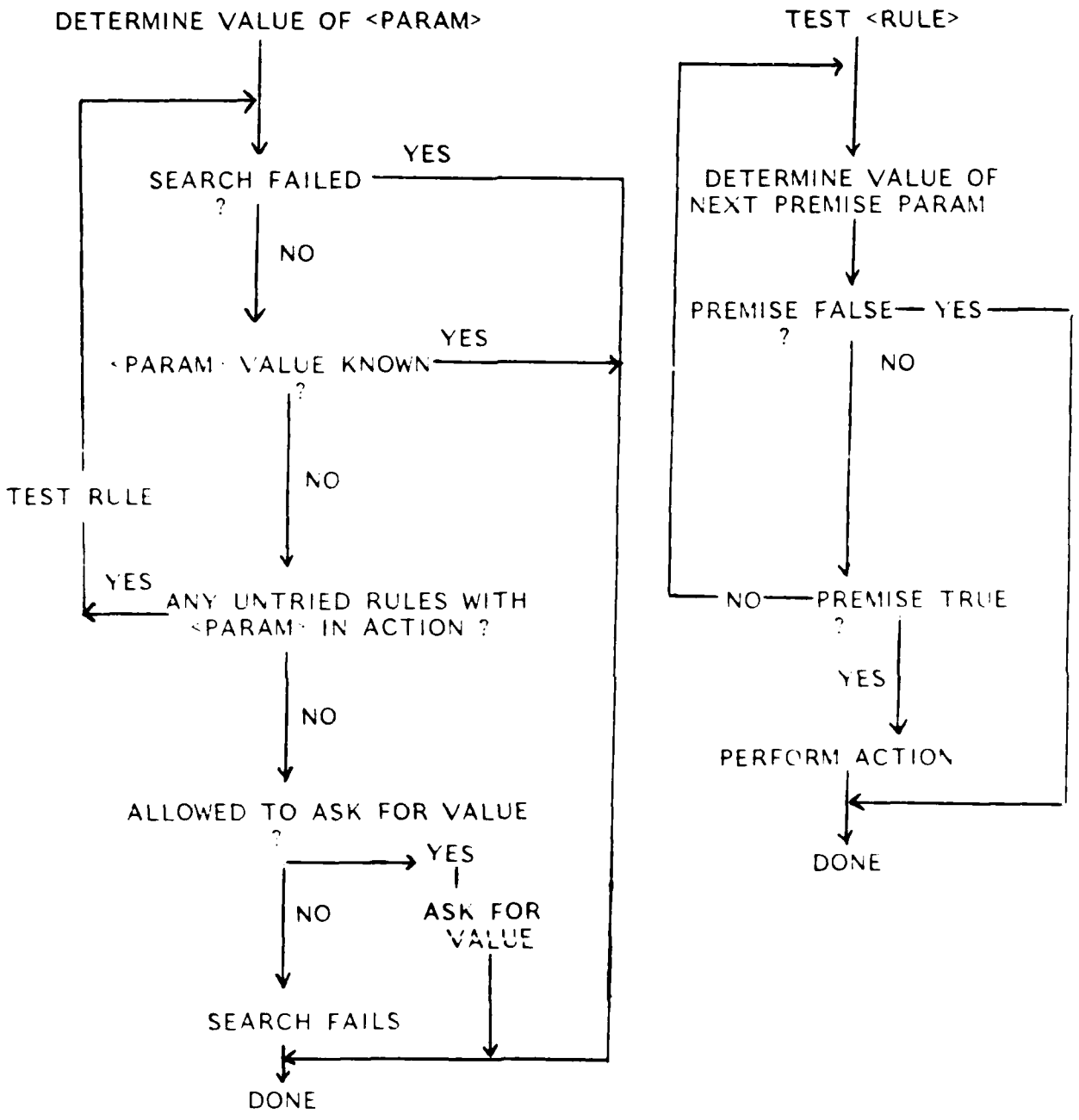


SAMPLE TREE

FIGURE 2

Backward-chaining initially analyzes the truthfulness of H1 by determining the values of H2, H3, where P1's value is known. To determine the value of H2, the system must look at the value of H4. To conclude H4, the system must look at P2's and P3's values. Finally, to determine the value of H3, the system must inspect P4 and P5. In other words, the system determines the value of the premise by first concluding the value of the associated action. The associated action then becomes the premise of another node further down the tree, and the process repeats until all hypotheses are determined by the values of their proofs. The present system incorporates many judgmental and empirical rules according to which the evidence supports a conclusion or hypothesis. As a final note, rules are neither implemented as subroutines nor embodied in any other part of the program code. The program uses rules as input to produce an internal representation which provides the expert system with expert knowledge specific to the task domain. The program itself is an interpreter and general reasoning mechanism. This important fact distinguishes the knowledge base from the inference engine.

Thus, the inference engine's primary functions are to accept and process problem queries from users to arrive at a solution while also allowing updates to the knowledge base. The following figure is taken from the *ELSIE A. EXPERT SYSTEM* developed by David Handleman, a graduate student at Princeton University. The diagram illustrates the inference engine's logic flow. **Determine Value Of <param>** and **Test <rule>** are user initiated function calls which execute the failure diagnosis. The backward-chaining search technique is employed.



INFERENCE ENGINE FLOWCHART
FIGURE 3

ROTORCRAFT MAINTENANCE EXPERT SYSTEM

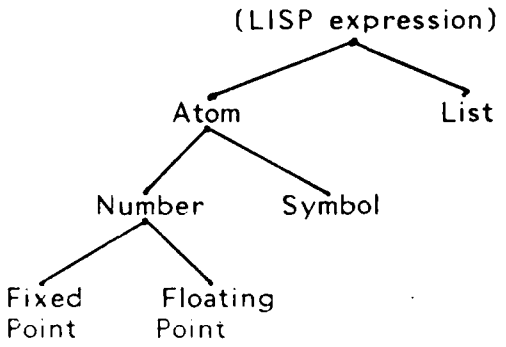
In the commercial and industrial sector, many companies have undertaken the development of AI types of systems for equipment maintenance [5]. The growing operational complexities of helicopters require an increased need for highly competent technicians to maintain the various systems in use. Maintenance tasks have become so complicated that few technicians capable of assessing malfunctioning equipment are available; consequently, there is an increased need for expert systems in the diagnosis/maintenance field to assist less-skilled workers. Furthermore, the time even highly-skilled workers need to investigate problems by referencing maintenance manuals can be saved by the use of an expert system.

The bottleneck in the field lies in the knowledge acquisition interface which is the most critical facet of building expert systems [6]. The problem domain's human expert must communicate with the "programmer" to collectively encode the expert system's knowledge base. The average maintenance technician must understand the dialogue employed in the expert system. All terms should be understandable and as natural as possible. The natural language interface is critical; hence, coupled with the inference procedure, the user interface provides the intelligence capability. The capacity to remember must occur while diagnosing specific problems. Answers to diagnostic questions and production rules accessed from the knowledge base must be remembered. The inherent recursive capabilities of LISP allow this to be effectively accomplished.

The expert system's organizational maintenance structure incorporates the operational checks of the rotorcraft system by isolating failures, adjustments, removals, and replacements of line item units all in accordance with maintenance and operational manual specifications. These manuals include general helicopter information, ground operations, environmental conditions, and extensive troubleshooting procedures. See Ref. 8 and 9. The CH-47 Chinook helicopter undergoes routine maintenance checks which necessarily require human manual tasks. The current manual procedures are quite arduous. This project investigates one feature of the manual procedure: the diagnosis of helicopter malfunctions relating to the flight control hydraulic system. This report provides design considerations for use of the expert system and illustrates the requirements for such an automated diagnostic system. The model is developed in LISP on the IBM Personal Computer XT to demonstrate the feasibility for full-scale maintenance expert systems.

LISP - THE LANGUAGE

Originated in 1958, LISP has built-in language functions to provide the string processing capabilities desired for AI programming. The language has since become the primary artificial intelligence programming language. Symbolic manipulation is required for computers to appear intelligent. LISP's functions are to recognize specific symbolic expressions, break down old expressions and assemble new expressions. The following diagram is excerpted from Winston and Horn's book LISP. See Ref. 7.



LISP STRUCTURE
FIGURE 4

The above diagram's thrust is to define both data and executable statements (functions). The atom is the smallest accessible element. A list is one atom or a list of atoms. A symbol is a user-created item or an available function. Executable statements are of a mathematical format in which the function call is represented as a list. The first element of the list is the function name while all other elements in the list are function arguments. The arguments also can be calls to other functions or, in a recursive process, to itself. The LISP function call is embedded in parentheses, which are used to indicate the function structure. Within LISP, there are approximately seventeen "primitively" defined categories of functions, in which a total of 83 LISP functions are defined.

INITIAL ASSUMPTIONS

The present knowledge base assumes a closed world rule space. In other words the knowledge base assumes by default that the only causal effects which result in device failures are those that are coded in

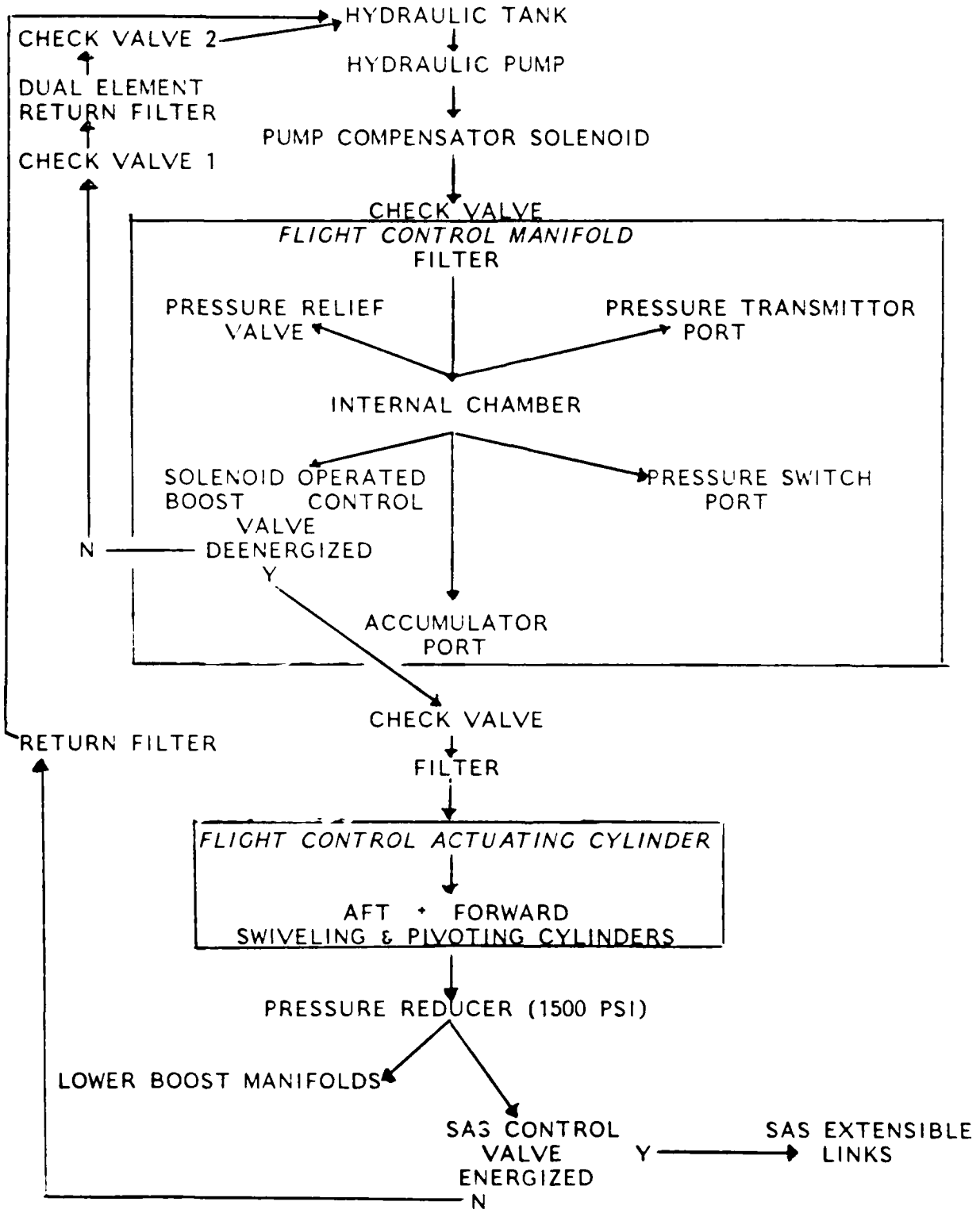
the parameters and rules. Of course, the rules are only as comprehensive as the source from which they were derived. Operation and maintenance manuals have been used as primary sources of information here. There are certain cases in the knowledge base when no rules can be used to determine the value of a particular parameter. Instead, the user is asked to provide the value of the unknown parameter. As more knowledge is accumulated about the system, the knowledge engineer can refine and perfect the knowledge base, eventually obviating any unnecessary user intervention. The present system derives its credibility from the accuracy and "expertness" of the aforementioned manuals.

DESCRIPTION OF FLIGHT CONTROL SYSTEM OPERATION

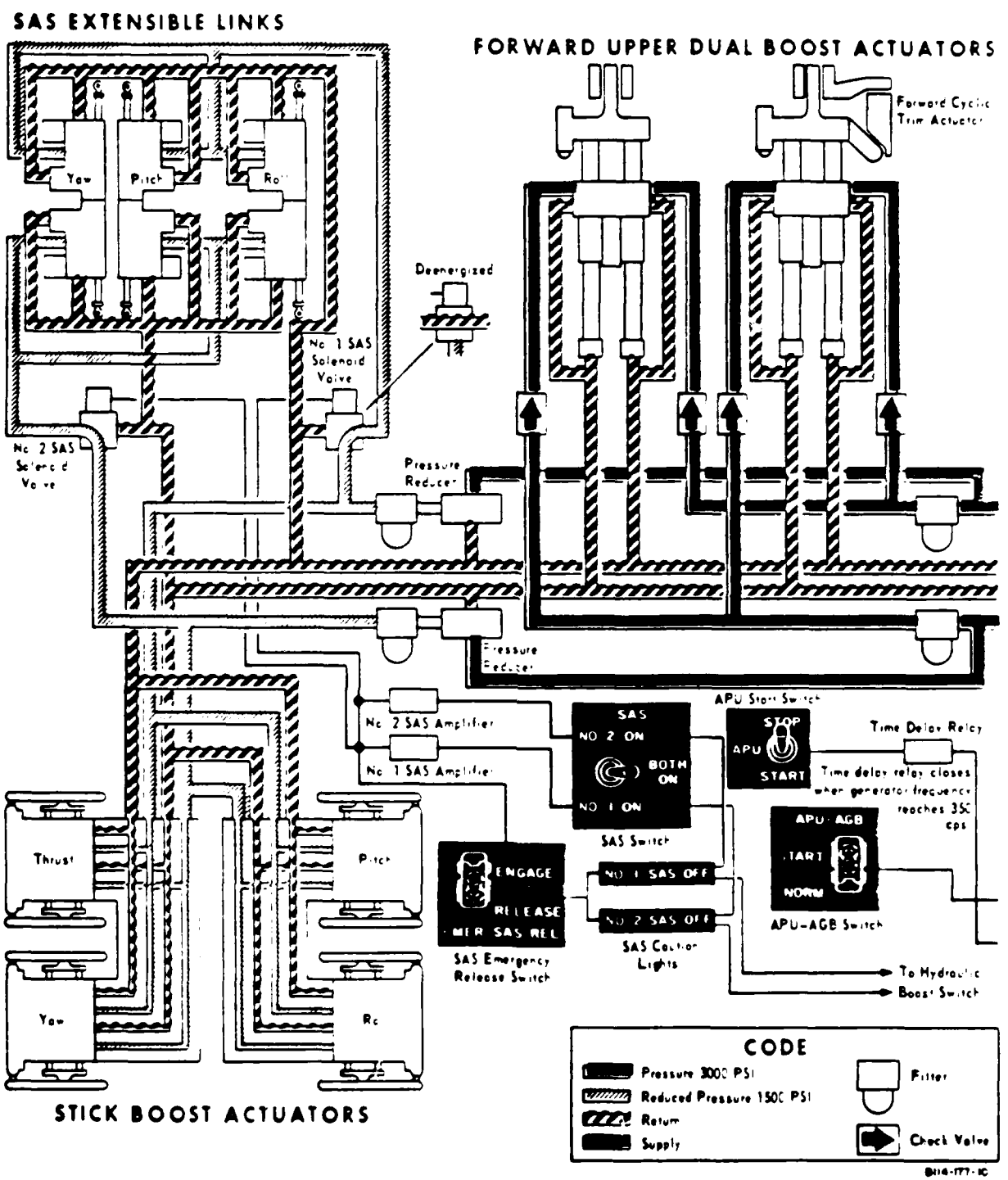
The flight control hydraulic system consists of two separate and independent systems [8]. Specifically, the two systems are parallel in operation, hydraulically separated, and electronically integrated [9]. The system provides boost to the pilot for flight control movements. The normal operating pressure is between 2500 and 3200 pounds per square inch (psi). Any pressure below 2500 psi is characterized by the system as abnormally low, and pressure above 3200 psi is considered abnormally high. Each system has its own hydraulic tank, pump, plumbing installations, and the concomitant valves, filters, and fittings. The flight control systems are labeled No.1 and No.2, and the HYDRAULIC BOOST switch on the control panel in the cockpit allows the pilot to alternate between systems when one system fails. Furthermore, each system provides hydraulic pressure to operate the forward

and aft pivoting and swiveling dual-actuating cylinders, the Stability Augmentation System (SAS), dual extensible link actuating cylinders, and dual stick boost actuating cylinders. The expert system's qualitative reasoning can be applied separately and independently to either flight control system. The expert system arbitrarily treats all data as referring to Flight Control System No. 1. Any references to the other system are, by default, Flight Control System No. 2.

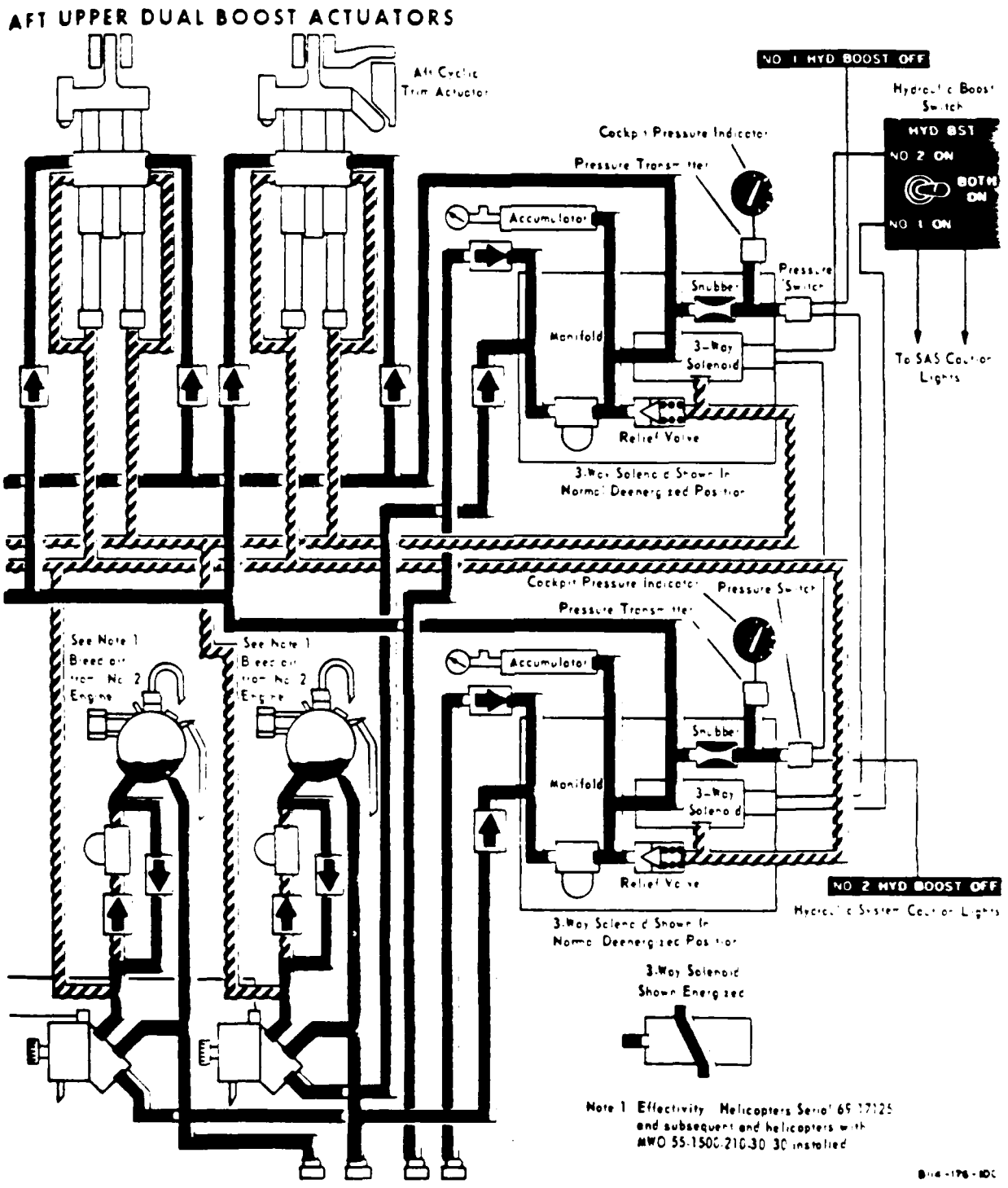
FIGURE 5 is a schematic flow of the working fluid through the system. Its purpose is to provide the user with a *general* idea of the flight control system's operation methodology. *FIGURE 6* and *FIGURE 7* provide the flight control hydraulic system layout, as diagrammed in Ref. 9.



HYDRAULIC FLIGHT CONTROL SYSTEM OPERATION
FIGURE 5



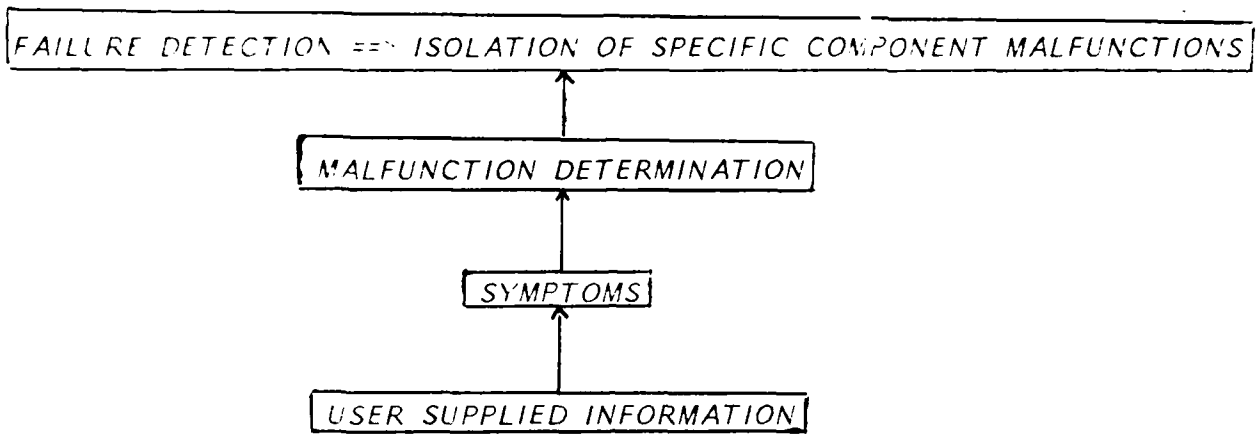
FLIGHT CONTROL HYDRAULIC SYSTEM (1/2)
FIGURE 6



FLIGHT CONTROL HYDRAULIC SYSTEM (2/2)
FIGURE 7

DISCUSSION OF PARAMETERS AND RULES

The knowledge base rule tree has essentialiy four major levels as illustrated in the following figure.



KNOWLEDGE BASE LEVELS
FIGURE 8

The controller uses the backward-chaining technique beginning from the top level down to determine the various parameters involved in the analysis. More critical than determining whether a failure is detected is deducing the specific devices which failed during the session. The inference engine hypothesizes the failure of a particular device, such as the pressure transmitter or the pressure filter. The inference engine, after internalizing the knowledge base by separating the antecedent and action side of all rules and developing a master list of parameter rule relationships, scans down this list, which has the device failure in question in its action clause. In order to prove the action, the engine must prove the antecedent. This becomes the new subgoal; hence, it is

the motivation behind the use of a backward-chaining search. The search scans all rules using a left-to-right ordering preference. For instance, in the top level tree in Appendix D, Rule 001 is fired before Rule 002. Hence, the absolute position of a rule in the master rule list is irrelevant; its relative position to related rules however is crucial to the expert system's efficiency and to its search speed. Primary rules are fired before secondary rules so that conclusions can be deduced more quickly. Instances where rules are not found to be applicable to a particular parameter determination may occur, and the system prompts the user for the necessary information. These should not be interpreted as holes in the knowledge base per se. In most cases, the nature of the data requested by the system has to be asked (e.g., the pressure value). In a real life situation, the maintenance technician would read the pressure value from a pressure gage.

The reader must keep in mind that the present knowledge base serves only to demonstrate the feasibility of a full-scale expert system. The knowledge incorporated only touches on the most general aspects of the flight control system while analyzing five devices in depth (pressure filter 114HS120-13 and 14, pressure filter 114HS120-15 and -16, pressure reducing valves 26C26602, pressure reducing valve 3A011, and flight control pump). The five devices are analyzed as in depth as any maintenance procedure will require. Specifically, for each device, the knowledge delves into the status of the component parts which comprise that device. In a full-scale expert system, there may be hundreds, even thousands, of such devices.

The expert system that has been developed is presently suited only for use in a laboratory environment. The system is heavily dependent on user interaction and to achieve any significant results, the user should be familiar with the general operation of the flight control hydraulic system. Such knowledge is required even of the maintenance technician who will eventually be called upon to operate this type of software package.

The results are promising. A knowledge base with 155 parameters and 258 rules has been incorporated. The system requires the user to respond generally in either the affirmative or the negative, with occasional responses of not applicable. The system interns this knowledge in order to generate more questions and eventually determine the specific devices which have malfunctioned as well as the concomitant corrective procedures.

The system provides responses which are realistic and in some instances border on the obvious. For example, if the pressure pump breaks down, then the system will inform the user to replace the pump. However, this simplicity should not be construed as a weakness; in fact, simplicity is the system's major strength. The structure of the knowledge base is such that additional rules can be added easily without changing the structure of the knowledge base. Thus, the knowledge base can be expanded indefinitely. Disk storage space is the only limitation.

A critical process in the development of an expert system is the transferral of expert knowledge from the maintenance manuals to a

high level programming language. The following illustration is taken from actual knowledge in the knowledge base. The source of the information comes from the August 16, 1978 issue of the *Aviation Unit and Aviation Intermediate Maintenance Manual*, published by the Army. See Ref. 8.

Pressure Filters 114HS120-13(17500) and -14(17510) Troubleshooting

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTIONS

Leak around pressure differential indicator.
STEP 1. Inspect for damaged sliding sleeve (40).
Replace spool assembly (43).

Numbers in parenthesis refer to component number in Figure 9.

ENGLISH TRANSCRIBED RULES

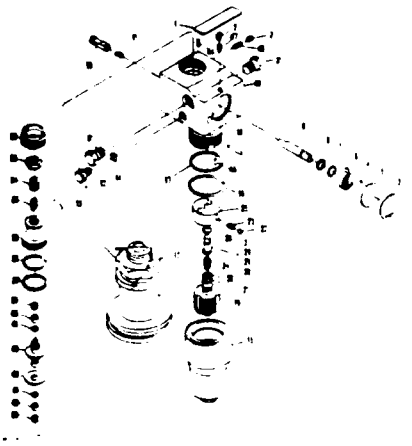
Rule AAA: If the pressure filters 114HS120-13 and -14 are not malfunctioning, then there is no leak around the pressure differential indicator.

(Notice that there is no rule which states that if the pressure filters are malfunctioning then there is a leak. Not enough information is available to make such a strong statement.)

Rule BBB: If there are leaks around the pressure differential indicator, then sliding sleeve (40) is damaged.

(Notice that such a strong statement is valid because the information does not suggest otherwise. Such a strong statement was determined independently of the user manual)

Rule CCC: If the sliding sleeve (40) is damaged, then replace spool assembly (43).



PRESSURE FILTER 114HS120-13, -14
FIGURE 9

CONCLUSIONS

This two-semester independent work's goal has been to develop a prototype knowledge based maintenance expert system. The results are threefold.

First, the source (Ref. 8 and 9) of the knowledge base has proved reliable and extremely useful in providing factual and heuristic rules. Operation and maintenance manuals were used; specifically, troubleshooting procedures were extensively implemented. In many instances, these procedures were directly transferred into if-then rules.

Second, LISP was found to be the ideal language to use in failure diagnostics. Its capabilities in list processing and parameter associations form the crux of the analysis. Also, LISP's capabilities in backward chaining prove instrumental in the project's ultimate success.

Finally, the feasibility for a full-scale expert system has been demonstrated by the successful testing of the present system. The proven workability of the knowledge base structure for a small-scale expert system is a great springboard from which to launch the development of a full-scale system. The troubleshooting procedures listed in Ref. 8 are crystal clear. No ambiguities were encountered in the development of the knowledge base for the present expert system. Therefore, the factual knowledge from which the knowledge was generated is of the highest integrity. Consequently, the system's artificially generated knowledge is also highly reliable.

The program and knowledge base are listed in the appendices. Specifically, Appendix A provides a user's guide and Appendix B presents a sample run. Appendix C presents and describes the list of parameters implemented in the knowledge base. Appendix D depicts the schematic representation of the knowledge base rules in a logical upward causal flow. Also, several figures of the devices (i.e. pressure reducer valve, pressure filter, etc.) are presented in an exploded view. The figures were taken from Ref. 8. Finally, Appendix E presents the actual code written in LISP. The rules' English translations are also included.

SUGGESTIONS FOR FUTURE WORK

The prototype expert system has provided keen insight into the enormous requirements (time and analysis tools) but unlimited potential for a full-scale maintenance expert system applied to failure detection and diagnosis of a Chinook CH-47 flight control hydraulic system. The present knowledge base already incorporates over two hundred- fifty rules and 150 parameters, yet it concentrates on only a fraction of the flight control system.

First, for a full-scale, in-depth operational maintenance system, **many** more man hours must be invested in this project in order to produce such a package. Commercially available maintenance expert systems generally have required up to ten man years to produce. Given the success of the prototype system, the development of a full-scale operational system within a few years is reasonable. Thus, the author recommends such an undertaking.

Second, a different search technique should be employed for a full-scale expert system. The problem domain in such an expert system imposes requirements for execution in real time. New architectures specifically designed for performing AI based tasks for large systems should consider a parallel type of search. This type of search divides the knowledge base into logical subsections and solves each subsection concurrently using a least constraint approach. The subsection requiring the least information is solved first; subsequently, other subsystems are solved.

Finally, the present computer facilities will prove wholly inadequate for a full-scale expert system implementation. The IBM Personal Computer XT has adequate "crunching" capabilities for the present knowledge base, but an IBM Personal Computer AT would be more desirable and use of such a machine could decrease processing time by up to threefold. Furthermore, an interpretive version of IQLISP rather than a compiled version has been used because of its availability. A compiled version of LISP would no doubt increase processing efficiency.

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Appendix A

USER'S GUIDE

The thrust of the user's guide is to provide background information on the computer tools used in developing the expert system and also to document a detailed step-by-step procedure to operate the expert system. The following procedures will assume that the user possesses a working knowledge of the MS-DOS Operating System prior to operating the expert system.

FEATURES

1. IBM Personal Computer XT
   - o 640K RAM
   - o MS-DOS Operating System
   - o 10M-byte fixed disk drive
   - o IBM 80 CPS Matrix printer

2. IQLISP (interpretive version)
   - o Version 1.7 November 1984
   - o Copyright (c) 1984 Integral Quality

STEP-STEP OPERATIONS PROCEDURE

A. Take master disk ==> copy onto hard disk (only if it is not already there)

1. >A	C:	[enter]	(change disk to hard disk)
2. >C	MKDIR YOURNAME	[enter]	(create your subdirectory)
3. >C	CD YOURNAME	[enter]	(get into subdirectory)
	*** only do step 2 or 3, not both! ***		
4. >C	COPY A: *.*	[enter]	(copies all files from) (floppy into subdirectory)

*** perform step 4 only if changes have been made to expert system shell or knowledge base ***

B.	IO DEVELOP.SYS	[enter]	(* prompt)
C.	(FLOAD "LOHKB")	[enter]	(loading knowledge base) (named LOHKB)

*** all entries should be in CAPITAL LETTERS ***

D. The following should appear on screen:
FLOAT
Reading knowledge base
Interning symbol group *PARAMETER-GROUP*
Interning symbol group *RULE-GROUP*
Finding parameter-rule relationships
..... etc.

E. Set certain parameters according to your preferences:
E.G. (SETQ VERBOSE NIL) ==> no intermediate steps will flush to screen

F. Proceed with analysis; follow instructions.
(FCHS = Flight Control Hydraulic System)

*** Option to send results to file ***
Perform following initiation before analysis:
(SETQ **MSG-FILE** (OUTPUT "FILENAME.TXT")) [enter]

G. To reinitialize system and perform another analysis:
(IKB) [enter] (to initialize knowledge base)
(EV) [enter] (to erase verification)

H. (EXIT) [enter] (to exit)

Appendix B

SAMPLE RUN

Appendix B contains a sample session which includes the system generated questions and diagnosis.

```
Initializing knowledge-base
Erasing verification information
Determining value of FAILURE-DETECTED

Q: Initial pressure check in FCHS is low - less than 2500 psi? (TRUE FAL~
SE)  PL

Q: Pressure in FCHS is between 450 and 550 psi after apu start? (TRUE FA~
LSE NA)  P-450-550

Q: Pressure in FCHS is between 2500 and 3200 psi after electric circuit
is disconnected? (TRUE FALSE NA)  NP-2500-3200

**********************************************************************
The ELECTRIC CIRCUIT to the flight control pump has been
determined to have failed due to pressure abnormality in pump
**********************************************************************

**********************************************************************
There is TRAPPED AIR at the PRESSURE TRANSMITTER in the flight
control hydraulic system indicated by hydraulic boost off
caution light being off
**********************************************************************

Q: Pressure indicator is low in FCHS? (TRUE FALSE NA)  PI-L

**********************************************************************
The PRESSURE INDICATOR in the flight control hydraulic system
has failed due to low or fluctuating pressure indication
**********************************************************************

**********************************************************************

The PRESSURE TRANSMITTER in the flight control hydraulic
system has failed due to low or fluctuating pressure indication
**********************************************************************

Q: Initial pressure check in FCHS is fluctuating? (TRUE FALSE)  PFL

Q: Initial pressure check in FCHS is zero? (TRUE FALSE)  PZ

Q: Trapped air in FCHS? (TRUE FALSE NA)  TA-IN-SYS

Q: Accumulator gage fluctuation in FCHS? (TRUE FALSE NA)  AG-F

Q: Initial pressure check in FCHS is high - greater than 3200 psi? (TRUE
 FALSE)  PH

Q: Temperature of hose fitting at pump pressure port in FCHS is greater
than temperature of hose fitting at pump case drain port by 28 degrees c~
elsius? (TRUE FALSE NA)  AGB-28

Q: Temperature of hose fitting at pump case drain port in FCHS is greate~
r than 102 degrees celsius? (TRUE FALSE NA)  BG-102

Q: Temperature of return line tube assembly at flight control manifold i~
n FCHS is greater than or equal to temperature of hose fitting at pump p~
ressure port? (TRUE FALSE NA)  TC-GTE-TA
```

Q: Temperature differential between inlet and outlet of flight control p~
ump in FCHS is abnormal? (TRUE FALSE NA) TDA-FCP

****
The FLIGHT CONTROL PUMP in the flight control hydraulic
system has failed due to abnormal temperature reading
at inlet and outlet of flight control pump
****

Q: Shaft seal leaks #4 in flight control pump? (TRUE FALSE NA) SSL4-FCP

Q: External leakage in flight control pump? (TRUE FALSE NA) EL-FCP

Q: Excessive hunting fluctuation or cavitation in flight control pump? (
TRUE FALSE NA) HFC-FCP

Q: Low pressure in flight control pump? (TRUE FALSE NA) LP-FCP

Q: High pressure in flight control pump? (TRUE FALSE NA) HP-FCP

Q: Temperature differential between inlet and outlet of pressure reduce
valve in FCHS is abnormal? (TRUE FALSE NA) TDA-PRV

****
PRESSURE REDUCE VALVE in flight control hydraulic system
has failed due to abnormal temperature differential between
inlet and outlet of pressure reduce valve**********~
****

Q: Temperature differential between inlet and outlet of flight boost acc~
umulator in FCHS is abnormal? (TRUE FALSE NA) TDA-FBA

****
FLIGHT BOOST ACCUMULATOR in flight control hydraulic system
has failed due to abnormal temperature differential between
inlet and outlet port of flight boost accumulator
****

Q: Temperature differential between inlet and outlet of hydraulic tank i~
n FCHS is abnormal? (TRUE FALSE NA) TDA-HT

Q: Temperature differential between inlet and outlet of pressure filter
in FCHS is abnormal? (TRUE FALSE NA) TDA-PF

****
The PRESSURE FILTER in flight control hydraulic system
has failed due to abnormal temperature differential between
inlet and outlet port of pressure filter
****

Q: Temperature differential between inlet and outlet of return filter in
FCHS is abnormal? (TRUE FALSE NA) TDA-RF

Q: Pressure reducing valve -2 -3 -8 are damaged? (OK FAILED) PRV238

Q: External leakage in pressure reducing valve 2 3 8? (TRUE FALSE NA) E~
-L-PRV238

Q: Static leakage in pressure reducing valve 2 3 8? (TRUE FALSE NA) S-L~
-PRV238

****
CYCLE the affected system long enough to moisten the seals
in the pressure reducing valve 238 due to static leakage
****

Q: Damaged or incorrectly installed packing #2 in pressure reducing valv~
e 2 3 8? (TRUE FALSE NA) PACKING2-PRV238

****
REPLACE PACKING #2 in the pressure reducing valve 238
in flight control hydraulic system due to damaged packing
****

Q: Relief flow from return port is not within specified limits in pressu~
re reducing valve 2 3 8? (TRUE FALSE NA) RET-PORT-PRV238

Q: Incorrectly adjusted relief valve #8 in pressure reducing valve 2 3 8
? (TRUE FALSE NA) IADJ-REL-VAL8-PRV238

Q: Faulty relief valve #8 in pressure reducing valve 2 3 8? (TRUE FALSE
NA) F-REL-VAL8-PRV238

Q: Leakage at reseat exceeds specified limits in pressure reducing valve
2 3 8? (TRUE FALSE NA) LEAKAGE-RESEAT-PRV238

Q: Flow from reg port not within specified limits in pressure reducing v~
alve 2 3 8? (TRUE FALSE NA) REG-PORT-PRV238

Q: Leakage from ret port exceeds specified limit in pressure reducing va~

lve 2 3 8? (TRUE FALSE NA) L-RET-PORT-PRV238

Q: Pressure reducing valves -11 is damaged? (OK FAILED) PRV3A

Q: Pressure filter 276 and -14 are damaged? (OK FAILED) PF1314

Q: Pressure filter 276 and -16 are damaged? (OK FAILED) PF1516

****
LOOSEN FLEXIBLE SUPPLY LINE to flight control pump
due to trapped air in system
****

****
LOOSEN LINE TO FLIGHT BOOST ACCUMULATOR
due to trapped air in system
****

Appendix C

LIST OF PARAMETERS

Appendix C presents the list of parameters that are to be used in the present knowledge base. The basis for the rules are drawn from maintenance and operation manuals - specifically the troubleshooting procedures. There are two levels or categories of parameters. The first level of parameters indicate the general diagnosis characteristics of the flight control system. These parameters aide the user in pinpointing the devices which caused the malfunction(s). The second level or focus parameters probe deeper into the flight control system. After the first level of parameters determine the device failure, the second level of parameters are used to determine the specific component(s) which caused the malfunction in the downed device.

LIST OF PARAMETERS

GENERAL PARAMETERS: (FIRST LEVEL)

PL - PRESSURE INDICATION IS LOW : (LESS THAN 2500 PSI)
PH - PRESSURE INDICATION IS HIGH : (GREATER THAN 3200 PSI)
PZ - PRESSURE INDICATION IS ZERO
PFL - PRESSURE INDICATION IS FLUCTUATING

P-450-550 - PRESSURE IS BETWEEN 450 AND 550 PSI AFTER APU START
NP-2500-3200 - NEW PRESSURE IS BETWEEN 2500 AND 3200 PSI
NP-EQ-P - NEW PRESSURE IS EQUAL TO PRESSURE
AGP-2500-3200 - ACCUMULATOR GAGE PRESSURE IS BETWEEN 2500 AND 3200 PSI

HBF-1CL-ON - HYD BOOST OFF SYSTEM 1 CAUTION LIGHT ON

PI-L - PRESSURE INDICATION IS LOW
PI-F - PRESSURE INDICATION IS FLUCTUATING

IPS - INOPERATIVE PNEUMATIC SYSTEM

AGP-EQ-P - ACCUMULATOR GAGE PRESSURE EQUAL TO COCKPIT PRESSURE INDICATION
AGB-28 - TEMPERATURE OF HOSE FITTING AT PUMP PRESSURE PORT IS GREATER THAN TEMPERATURE OF HOSE FITTING AT PUMP CASE DRAIN PORT BY 28 DEGREES CELSIUS
BG-102 - TEMPERATURE OF HOSE FITTING AT PUMP CASE DRAIN PORT IS GREATER THAN 102 DEGREES CELSIUS
TC-GTE-TA - TEMPERATURE OF RETURN LINE TUBE ASSEMBLY AT FLIGHT CONTROL MANIFOLD IS GREATER THAN OR EQUAL TO TEMPERATURE OF HOSE FITTING AT PUMP PRESSURE PORT

TDA-COMPONENTX - TEMPERATURE DIFFERENTIAL BETWEEN INLET AND OUTLET PORT OF COMPONENT X IS ABNORMAL
TDA-PRV - COMPONENTX=PRESSURE REDUCE VALVE
TDA-FBA - COMPONENTX=FLIGHT BOOST ACCUMULATOR
TDA-FCP - COMPONENTX=FLIGHT CONTROL PUMP
TDA-HT - COMPONENTX=HYDRAULIC TANKS
TDA-PF - COMPONENTX=PRESSURE FILTER
TDA-RF - COMPONENTX=RETURN FILTER

TA-IN-SYS- TRAPPED AIR IN SYSTEM

AG-F - ACCUMULATOR GAGE FLUCTUATION

POSSIBLE DEVICE FAILURES/CORRECTIVE ACTIONS:

EC-FCP - ELECTRIC CIRCUIT TO FLIGHT CONTROL PUMP
SH-BO2 - SET HYDRAULIC BOOST 2 ON
FCM - FLIGHT CONTROL MANIFOLD
TA-AT-PT - TRAPPED AIR AT PRESSURE TRANSMITTER
PI - PRESSURE INDICATOR
PT1 - PRESSURE TRANSMITTER DETERMINATION INDICATED BY PRESSURE INDICATION VALUE
PT2 - PRESSURE TRANSMITTER DETERMINATION INDICATED BY ACCUMULATOR GAGE PRESSURE INDICATION BETWEEN 2500 AND 3200 PSI
PT3 - PRESSURE TRANSMITTER DETERMINATION INDICATED BY ACCUMULATOR GAGE FLUCTUATION
FCP1 - FLIGHT CONTROL PUMP DETERMINATION INDICATED BY ACCUMULATOR GAGE PRESSURE
FCP2 - FLIGHT CONTROL PUMP DETERMINATION INDICATED BY TEMPERATURE AT HOSE FITTING
FCP3 - FLIGHT CONTROL PUMP DETERMINATION INDICATED BY TEMPERATURE DIFFERENTIAL AT INLET AND OUTLET PORT
FCM - FLIGHT CONTROL MANIFOLD
PRV - PRESSURE REDUCE VALVE
FBA - FLIGHT BOOST ACCUMULATOR
HT - HYDRAULIC TANK
PF - PRESSURE FILTER
RF - RETURN FILTER
L-FS-L - LOOSEN FLEXIBLE SUPPLY LINE TO PUMP
L-FBA-L - LOOSEN LINE TO FLIGHT BOOST ACCUMULATOR

GOAL: (FIRST LEVEL)

FAILURE-DETECTED - GOAL OF THE EXPERT SYSTEM: TO DETERMINE WHETHER THE FAILURE DEVICE HAS BEEN DEDUCED OR IF THERE INDEED IS A FAILURE

ALL-DEVICES-TESTED - TO DETERMINE WHETHER ALL DEVICES WERE TESTED

NOTHING-FAILED - TO DETERMINE WHETHER ANY DEVICES FAILED OR CORRECTIVE ACTIONS TAKEN

Completed December 31, 1985

FOCUS PARAMETERS FOR FLIGHT CONTROL PUMP

SSL4-FCP - SHAFT SEAL LEAKS #4
CFEPS-FCP - CARBON-FACED ENCASED PLAIN SEAL DAMAGED
R-SEAL4-FCP - REPLACE THE SEALS #4
EL-FCP - EXTERNAL LEAKAGE
LAP-FCP - LOOSE ATTACHING PARTS
T-BOLTS-FCP - TIGHTEN BOLTS OR SCREWS IN LEAKING AREAS
PACKING-FCP - DAMAGED OR TWISTED PACKINGS
R-PACKING-FCP - REPLACE THE PACKINGS
SNMATSUR-FCP - SCORING OR NICKS ON MATING SURFACES
R-PUMP1-FCP - REPLACE THE PUMPS DUE TO SCORING OR NICKS AT MATING SURFACES
R-PUMP2-FCP - REPLACE THE PUMPS DUE TO STICKING COMPENSATOR SPRING #11 AND #12
R-PUMP3-FCP - REPLACE THE PUMPS DUE TO LOOSE OR STICKING SPOOL VALVE #13
R-PUMP4-FCP - REPLACE THE PUMPS DUE TO BROKEN COMPENSATOR SPRING #11 AND #12
R-PUMP5-FCP - REPLACE THE PUMPS DUE TO FAULTY COMPENSATOR ACTION #14
HFC-FCP - EXCESSIVE HUNTING, FLUCTUATION OR CAVITATION
SCOMPSPR1112-FCP - STICKING COMPENSATOR SPRING #11 AND #12
LSSPOOLV13-FCP - LOOSE OR STICKING SPOOL VALVE #13
LP-FCP - LOW PRESSURE IN FLIGHT CONTROL PUMP
BCOMPSPR1112-FCP - BROKEN COMPENSATOR SPRING #11 AND #12
HP-FCP - HIGH PRESSURE IN FLIGHT CONTROL PUMP
FCOMPENSATOR14-FCP - FAULTY COMPENSATOR ACTION #14

FOCUS PARAMETERS FOR PRESSURE FILTER 13, 14

PF1314 - PRESSURE FILTER 114HS120-13 AND -14 ARE DAMAGED
LBOHEA-PF1314 - LEAK BETWEEN BOWL AND HEAD ASSEMBLY
PACKING7-PF1314 - DAMAGED PACKINGS # 7
R-BOWL-PACKING-PF1314 - REMOVE BOWL AND REPLACE PACKING
LPDIFFIND-PF1314 - LEAK AROUND PRESSURE DIFFERENTIAL INDICATOR
DAMSLSL40-PF1314 - DAMAGED SLIDING SLEEVE #40
R-SPOOL43-PF1314 - REPLACE SPOOL ASSEMBLY #43
LADPLUG-PF1314 - LEAK AT ADJUSTING PLUG
PDIFFINDE-PF1314 - PRESSURE DIFFERENTIAL INDICATOR EXTENDED; FILTER ELEMENT CLEAN
INADPDIFF-PF1314 - INCORRECTLY ADJUSTED PRESSURE DIFFERENTIAL DROP
C-ADJUSTMENT-PF1314 - CORRECT ADJUSTMENT
LBLEPL-PF1314 - LEAK AT BLEED PLUG
PACKING14-PF1314 - DAMAGED PACKING #14
R-PLUG-PACKING14-PF1314 - REMOVE PLUG AND REPLACE PACKING

FOCUS PARAMETERS FOR PRESSURE FILTER 15, 16

PF1516 - PRESSURE FILTER 114HS120-15 AND -16 ARE DAMAGED
LBOHEA-PF1516 - LEAKAGE BETWEEN BOWL AND HEAD
PACKING3-PF1516 - FAULTY PACKING #3

R-PACKING3-PF1516 - REPLACE PACKING #3
LHEIND-PF1516 - LEAKAGE BETWEEN HEAD AND INDICATOR
LOOIND15-PF1516 - LOOSE INDICATOR #15
T-INDICATOR15-PF1516 - TIGHTEN INDICATOR
EXPRD-PF1516 - LOW OUTPUT, EXCESSIVE PRESSURE DROP
PACKING8-PF1516 - DAMAGED PACKING #8
R-PACKING8-PF1516 - REPLACE PACKING #8
CLGD-ELEMENT5-PF1516 - CLOGGED OR DIRTY ELEMENT #5
C-R-ELEMENT-PF1516 - CLEAN OR REPLACE ELEMENT
SHOVAL10-PF1516 - SHUTOFF VALVE #10 NOT PROPERLY OPENED
R-PART10-PF1516 - REPLACE DEFECTIVE PART OF SHUTOFF VALVE
LSVH-PF1516 - EXCESSIVE LEAKAGE BETWEEN SHUTOFF VALVE AND HEAD
DAM-SESURFH-PF1516 - DAMAGED SEALING SURFACE ON HEAD
R-FIL-ASSEMBLY-PF1516 - REPLACE FILTER ASSEMBLY
INDPP15-PF1516 - INDICATOR #15 DOES NOT ACTUATE AT PRESET PRESSURE
R-INDICATOR15-PF1516 - REPLACE INDICATOR #15

FOCUS PARAMETERS FOR PRESSURE REDUCING VALVES 26C26602, 03, 08

PRV238 - PRESSURE REDUCING VALVE 26C26602, 03, 08 ARE DAMAGED
CYCLE-SYSTEM-PRV238 - CYCLE THE AFFECTED SYSTEM LONG ENOUGH TO MOISTEN THE SEALS.
E-L-PRV238 - EXTERNAL LEAKAGE
S-L-PRV238 - STATIC LEAKAGE
PACKING2-PRV238 - DAMAGED OR INCORRECTLY INSTALLED PACKING #2
R-PACKING2-PRV238 - REPLACE PACKING #2
RET-PORT-PRV238 - RELIEF FLOW FROM RETURN PORT IS NOT WITHIN SPECIFIED LIMITS
IADJ-REL-VAL8-PRV238 - INCORRECTLY ADJUSTED RELIEF VALVE #8
A-REL-VAL8-PRV238 - ADJUST RELIEF VALVE #8
F-REL-VAL8-PRV238 - FAULTY RELIEF VALVE #8
R-REL-VAL8-PRV238 - REPLACE RELIEF VALVE #8 ASSEMBLY AS A MATCHED SET
LEAKAGE-RESEAT-PRV238 - LEAKAGE AT RESEAT EXCEEDS SPECIFIED LIMITS
SPRING13-PRV238 - FAULTY SPRING #13
R-SPRING13-PRV238 - REPLACE SPRING #13
REG-PORT-PRV238 - FLOW FROM REG PORT NOT WITHIN SPECIFIED LIMITS
REDUCER-VAL12-PRV238 - INCORRECTLY ADJUSTED REDUCER VALVE #12
A-RED-VAL12-PRV238 - ADJUST REDUCER VALVE #12
POPPET21-SLEEVE22-PRV238 - FAULTY POPPET #21 AND SLEEVE ASSEMBLY #22
R-POPPET21-SLEEVE22-PRV238 - REPLACE POPPET AND SLEEVE ASSEMBLY AS A MATCHED SET
L-RET-PORT-PRV238 - LEAKAGE FROM RET PORT EXCEEDS SPECIFIED LIMIT
PACKING1923-PRV238 - DAMAGED OR INCORRECTLY INSTALLED PACKINGS #19 AND #23
R-PACKING1923-PRV238 - REPLACE PACKINGS #19 AND #23

FOCUS PARAMETERS FOR PRESSURE REDUCING VALVE 3A011

PRV3A - PRESSURE REDUCING VALVE 3A011 IS DAMAGED
E-L-PRV3A - EXTERNAL LEAKAGE
PACKING410-PRV3A - DAMAGED PACKING #4 OR #10

R-PACKING410-PRV3A - REPLACE PACKING #4 OR #10
RING39-PRV3A - INCORRECTLY ASSEMBLED BACKUP RINGS #3 OR #9
R-RING39-PRV3A - REMOVE AND REASSEMBLE BACKUP RING #3 OR #9
EX-L-RETPORT-PRV3A - EXCESSIVE INTERNAL LEAKAGE THROUGH RETURN PORT
PACKING2123-PRV3A - DAMAGED PACKING #21 OR #23
R-PACKING2123-PRV3A - REPLACE PACKING #21 OR #23
RING20-PRV3A - INCORRECTLY ASSEMBLED BACKUP RING #20
R-RING20-PRV3A - REMOVE AND REASSEMBLE BACKUP RING #20
EX-FLOW-RETPORT-PRV3A - EXCESSIVE FLOW THRU RETURN PORT DURING LEAKAGE TEST
PLUNGER14-BARREL15-PRV3A - INTEGRAL RELIEF VALVE CRACKS DUE TO PRESSURE BUILD-UP CAUSED BY LEAKAGE THROUGH SEAT ON BARREL #15
R-PLUNGER14-BARREL15-PRV3A - REPLACE PLUNGER #14 AND BARREL #15
DASHPOT16-PRV3A - INCORRECTLY ASSEMBLED DASHPOT #16
R-DASHPOT16-PRV3A - REMOVE AND REASSEMBLE DASHPOT #16
REL-VAL-LOW-PRV3A - INTEGRAL RELIEF VALVE CRACKS LOW AT CORRECT PRESSURE SETTING
BALL-SEAT19-PRV3A - DAMAGED BALL SEAT #19
R-BALL-SEAT19-PRV3A - RESEAT OR REPLACE BALL SEAT #19
REL-VAL-HIGH-PRV3A - INTEGRAL RELIEF VALVE CRACKS HIGH AND RESEATS LOW
PUSHROD17-BARREL15-PRV3A - BINDING BETWEEN PUSHROD #17 AND BARREL #15 IS FAULTY
BUFF-CLEAN1-PRV3A - BUFF AND CLEAN PUSHROD #17 AND BARREL #15 AND CHECK FOR SMOOTH FIT
BUFF-CLEAN2-PRV3A - BUFF AND CLEAN BINDING BETWEEN VARIOUS COMPONENTS
VAL-RED-PRV3A - VALVE FAILS TO REDUCE CORRECTLY
BINDING-PRV3A - BINDING BETWEEN VARIOUS COMPONENTS FAULTY
WRONG-PACKING-PRV3A - INCORRECT ASSEMBLY OR WRONG SIZE PACKING
R-PACKING-PRV3A -REMOVE AND REASSEMBLE PACKING
VAL-SQUEALS-PRV3A - VALVE CHATTERS OR SQUEALS
C-PLUNGER14-PRV3A - CHECK FOR FREE FIT WITH PLUNGER #14 AND REASSEMBLE
PACKING12-WASHER11-PRV3A - INCORRECT ASSEMBLY OF PACKING #12 AND WASHER #11
R-PACKING12-WASHER11-PRV3A - REMOVE AND REASSEMBLE PACKING #12 AND WASHER #11
FITTING8-PRV3A - TIGHT FITTING #8
R-FITTING8-PRV3A - UNSCREW AND RETORQUE FITTING #8 TO 250 POUND-INCHES

Completed April 23, 1986

For a more complete description of the parameters used above, consult Ref. 8.

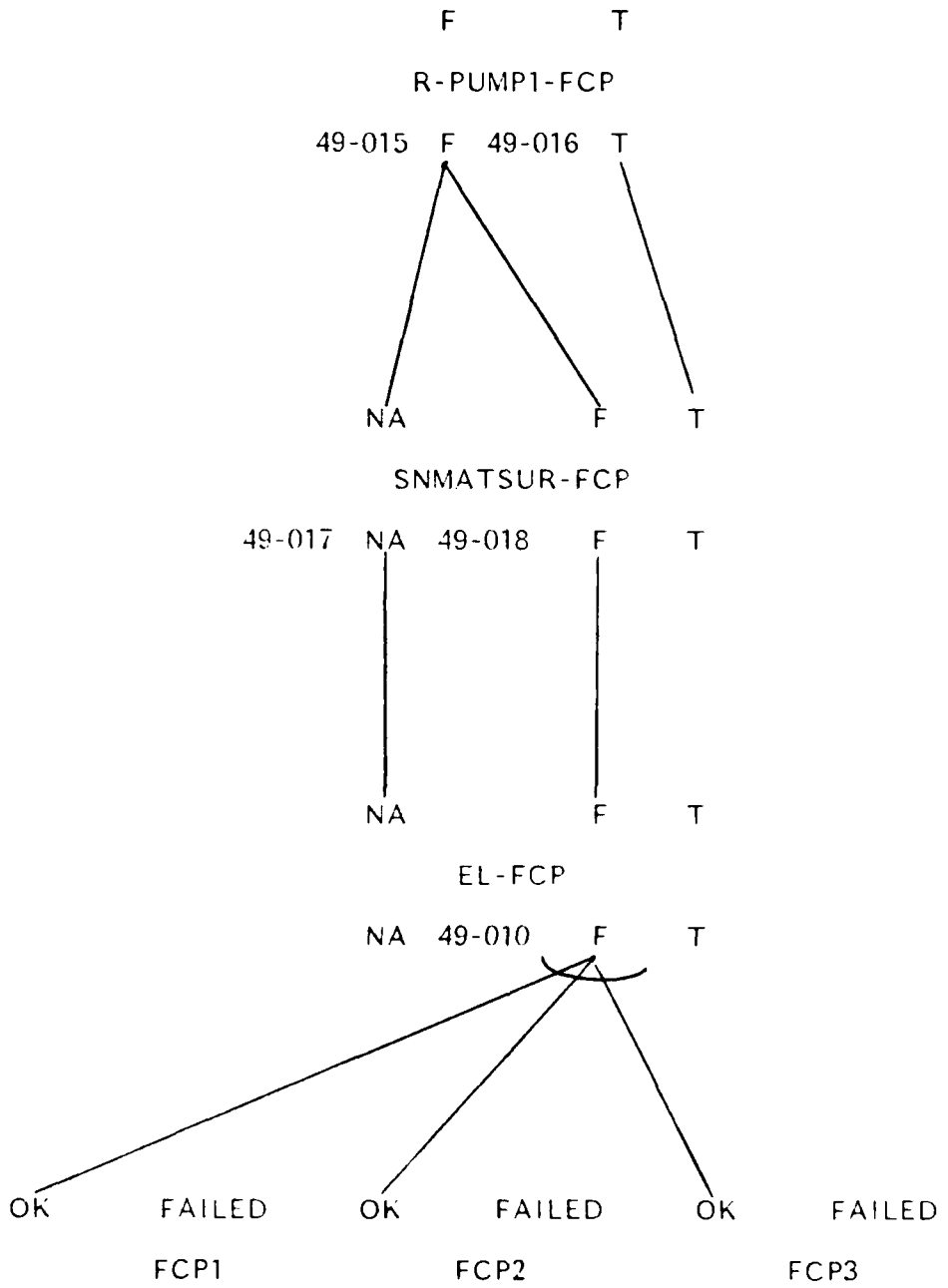
Appendix D

FAILURE DIAGNOSIS RULES

The expert system uses rules and a global data base to diagnose failures. Appendix D concentrates on the diagrammatical upward causal flow of the knowledge base. The symbol $\bigwedge$ symbolizes the OR function and the symbol $\underline{\bigwedge}$ symbolizes the AND function. The value NA denotes NOT APPLICABLE. This is an alternative to the boolean values TRUE and FALSE. In addition, the inference engine should produce all possible device failures. The system should NEVER return an unknown value for a possible device failure. As an illustration of the use of the schematic diagrams, the English translation of RULE ONE is as follows: "*If all devices tested is true and nothing failed is true then failure detected is false.*"

An in-depth example with explanation follows on the next page. The example refers to a set of corrective actions applied to defective flight control pumps.

CORRECTIVE ACTIONS: FAULTY FLIGHT CONTROL PUMP
REPLACE THE PUMPS



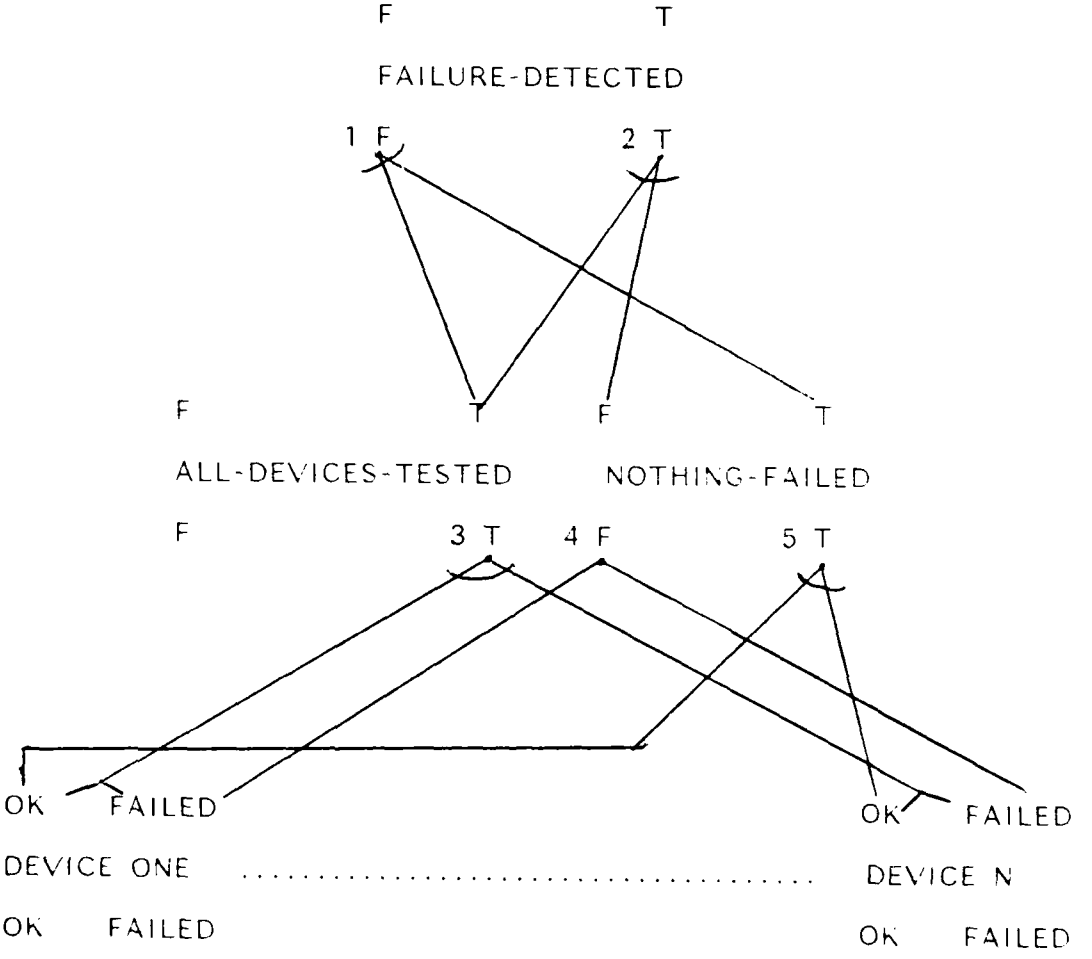
EXPLANATION OF PREVIOUS LOGIC TREE: REPLACE THE PUMPS

The inference engine determines the value of parameter R-PUMP1-FCP (replace the pump in the flight control system **due** to scoring or nicks on the mating surfaces). To accomplish the feat, the engine backward chains and inquires about the value of SNMATSUR-FCP (scoring or nicks on mating surfaces). Notice that a value of NA (not applicable) or FALSE for SNMATSUR-FCP implies that one not need replace the pump **due** to SNMATSUR-FCP and says nothing about whether to replace the pump due to other circumstances. The use of the FALSE value for SNMATSUR-FCP is straightforward. When SNMATSUR-FCP takes on a value of NA is not quite as obvious. This value denotes that only insufficient evidence for SNMATSUR-FCP to determine whether it is TRUE or FALSE is available. Since a true value of R-PUMP1-FCP means to replace the pump solely due to scoring, nicks etc., then a NA value of SNMATSUR-FCP necessarily implies that R-PUMP1-FCP is false. If, on the other hand, R-PUMP1-FCP were denoted as to replace the pump for some general case, then a value of NA for SNMATSUR-FCP cannot imply that R-PUMP-FCP is FALSE.

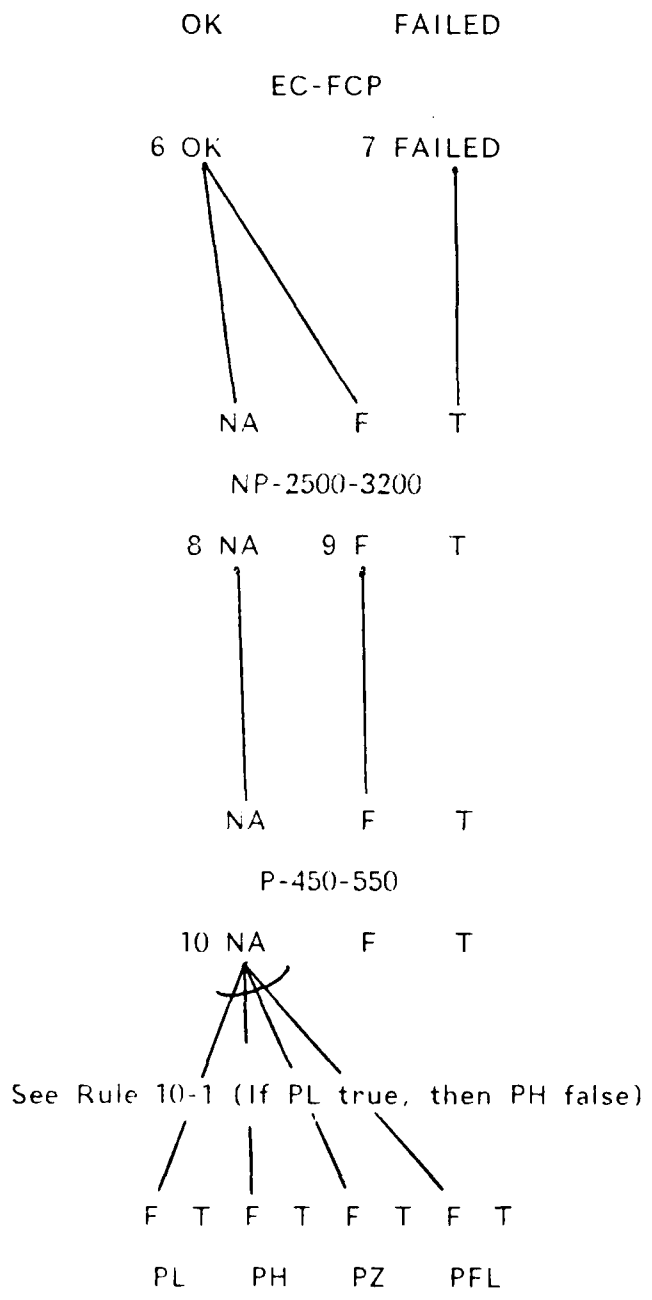
The remainder of the rules applied for this corrective procedure is straightforward. If the external leakage in the flight control pump (EL-FCP) is NOT APPLICABLE then scoring or nicks on the mating surface (SNMATSUR-FCP) is also NOT APPLICABLE. The same logic is applied when both of the parameters are false. Finally, when the flight control pump (FCP1, FCP2, FCP3) is OK, then there cannot possibly be any external leakages, hence the parameter EL-FCP must by necessity

be FALSE. Notice that no rule states that if the flight control pump has failed, then there must be an external leakage in the flight control pump. A faulty flight control pump could mean several possible failures, not exclusively external leakages.

TOP LEVEL


F
T
FAILURE-DETECTED
1 F
2 T
F
T
F
T
ALL-DEVICES-TESTED
NOTHING-FAILED
F
3 T
4 F
5 T
OK
FAILED
OK
FAILED
DEVICE ONE
DEVICE N
OK
FAILED
OK
FAILED

ELECTRIC CIRCUIT TO FLIGHT CONTROL PUMP



SET HYDRAULIC BOOST TWO ON

NO YES

SH-BO2

11 NO 12 YES

NA F T

AGP-2500-3200

13 NA 14 F T

(See RULE015 in source code)

NA F T

NP-EQ-P

16 NA 17 F T

NA F T

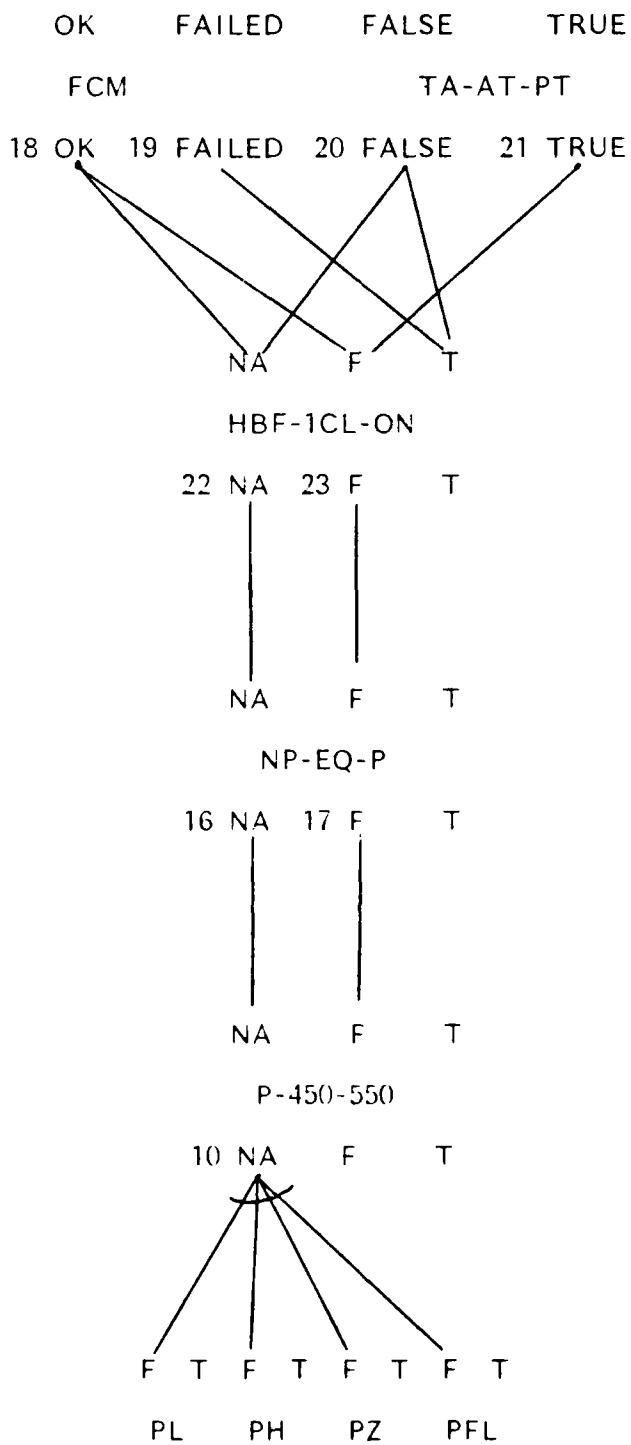
P-450-550

10 NA F T

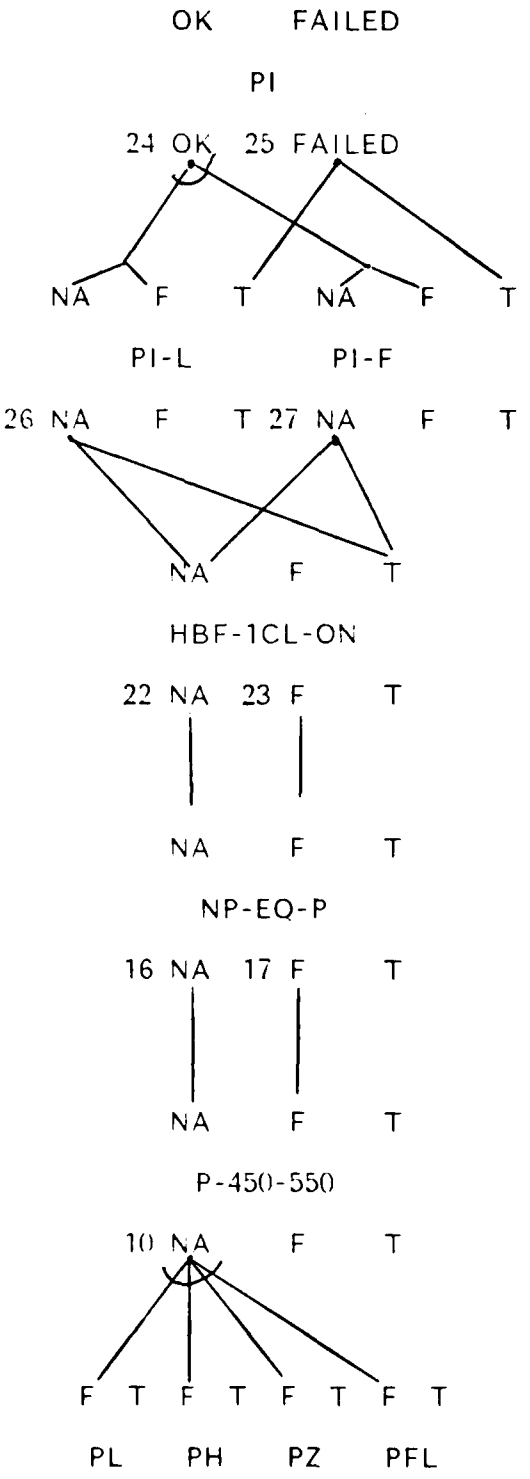
F T F T F T F T

PL PH PZ PFL

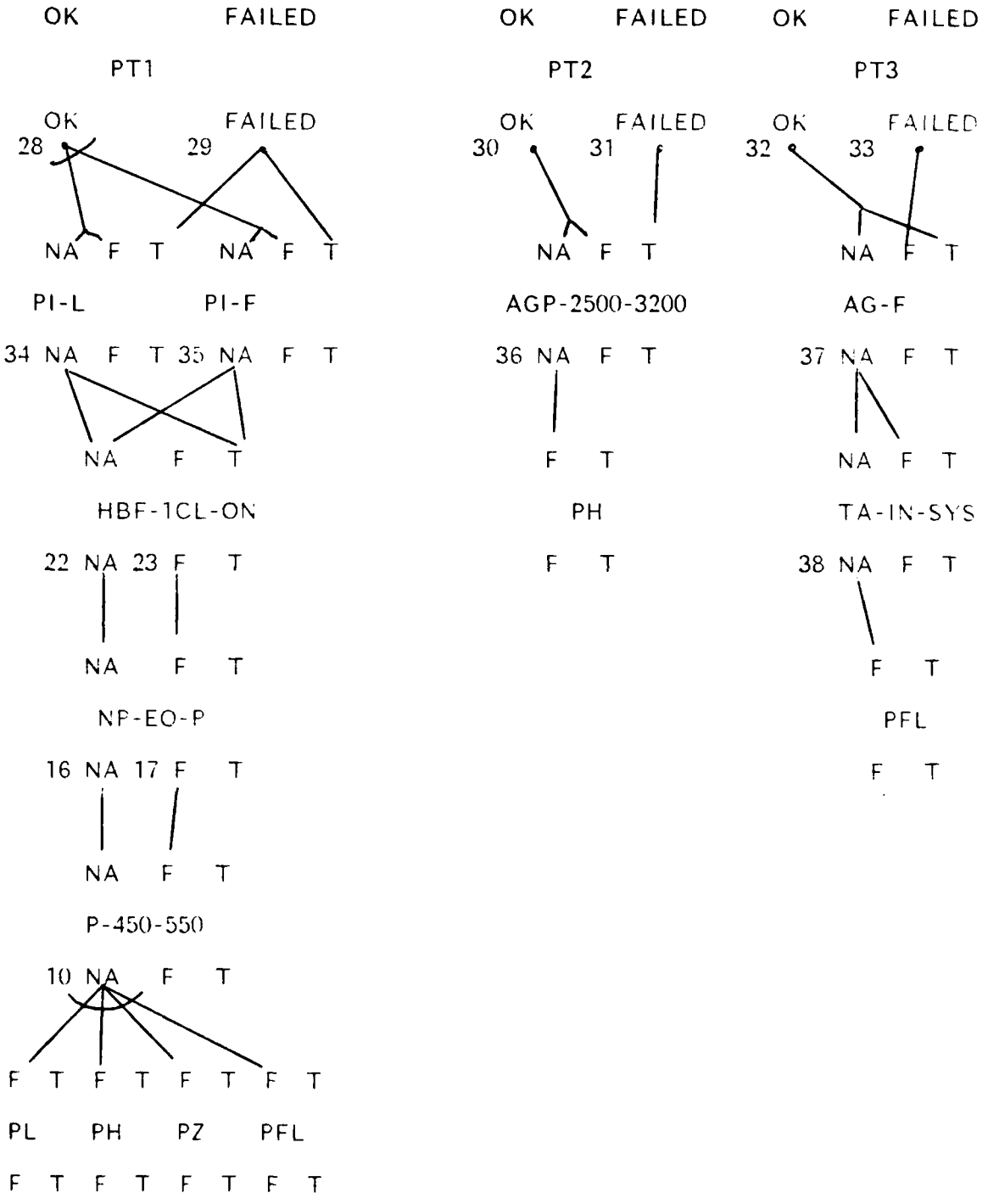
FLIGHT CONTROL MANIFOLD & TRAPPED AIR AT PRESSURE TRANSMITTER



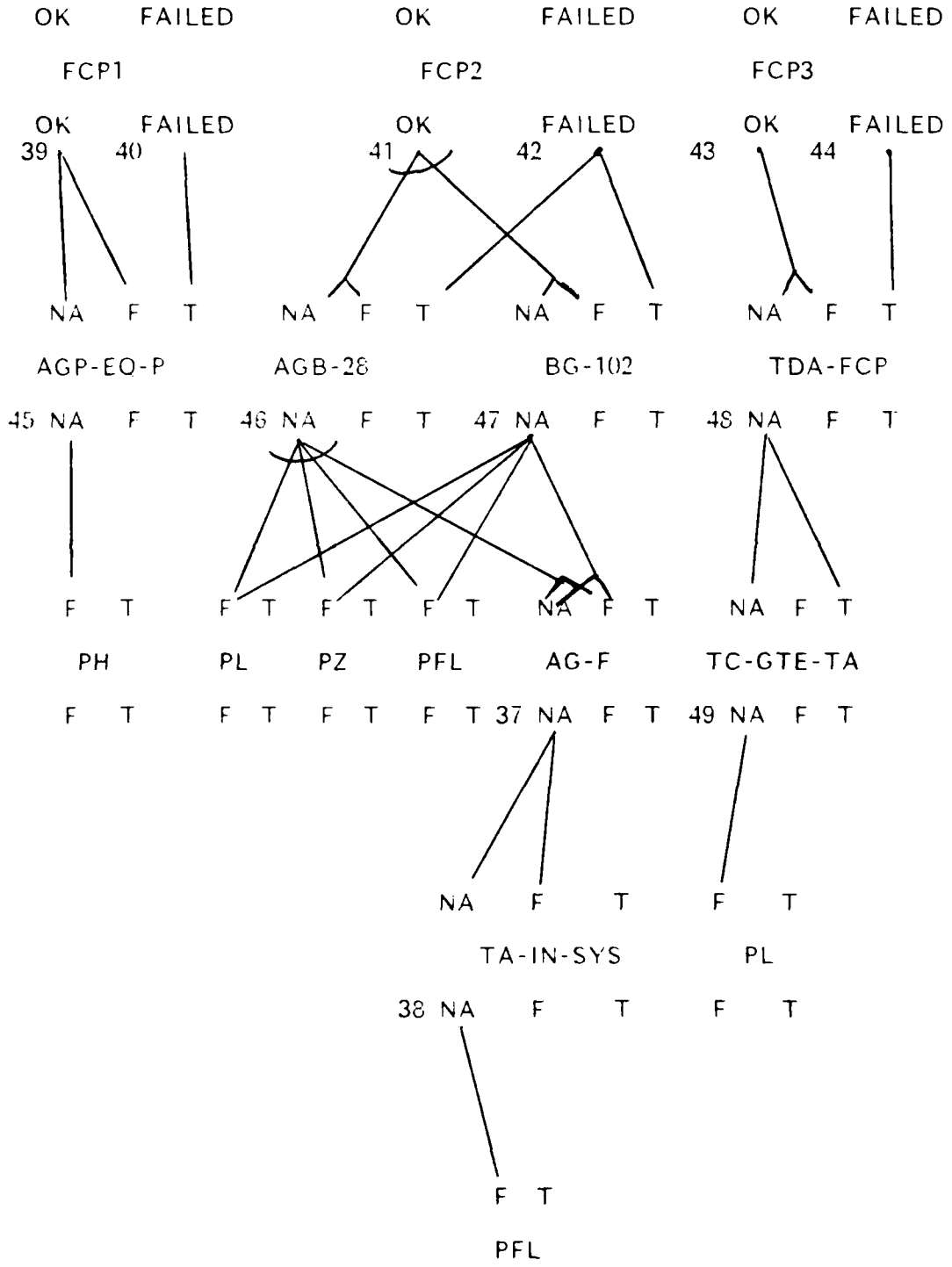
PRESSURE INDICATOR



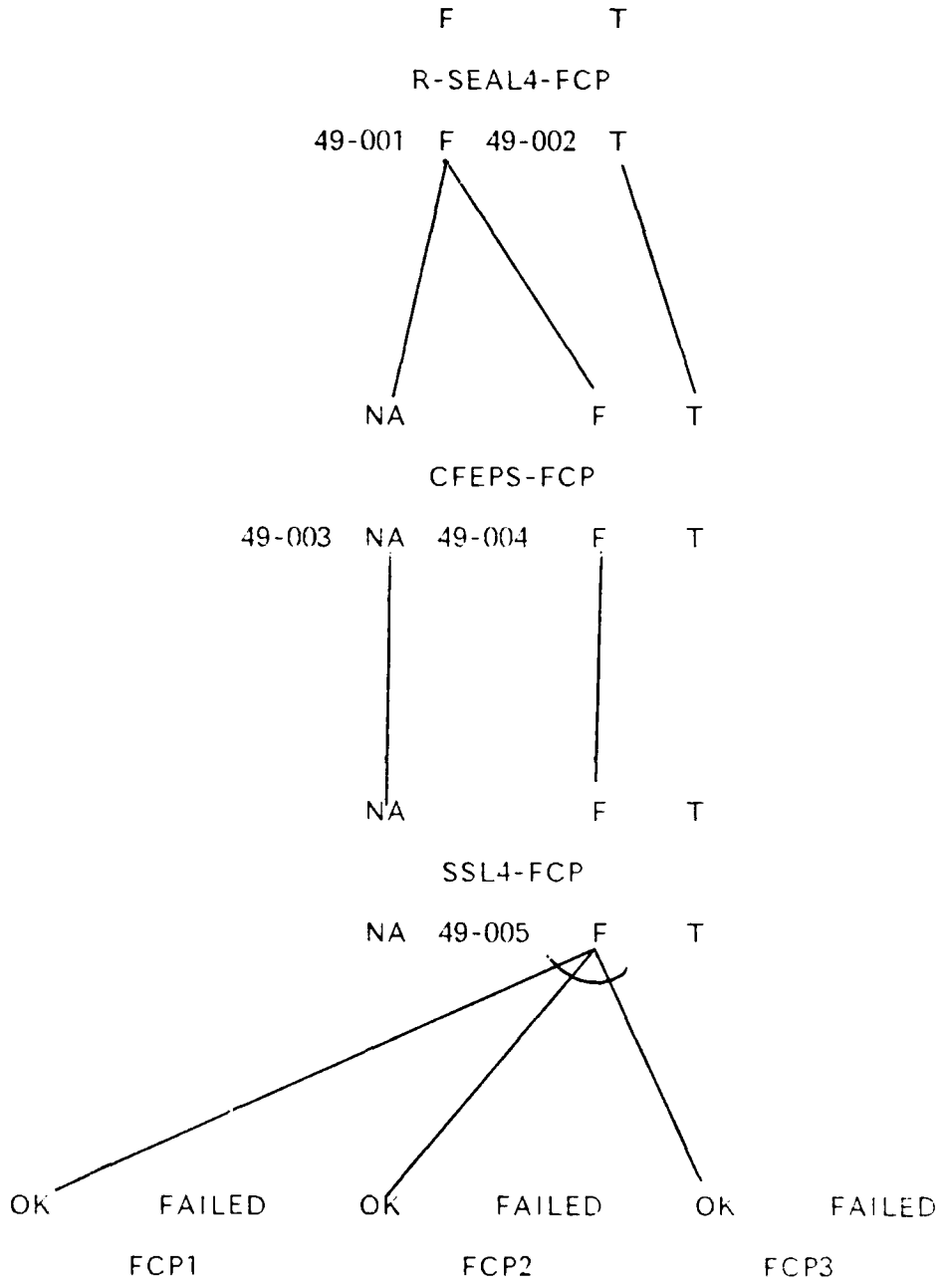
PRESSURE TRANSMITTER



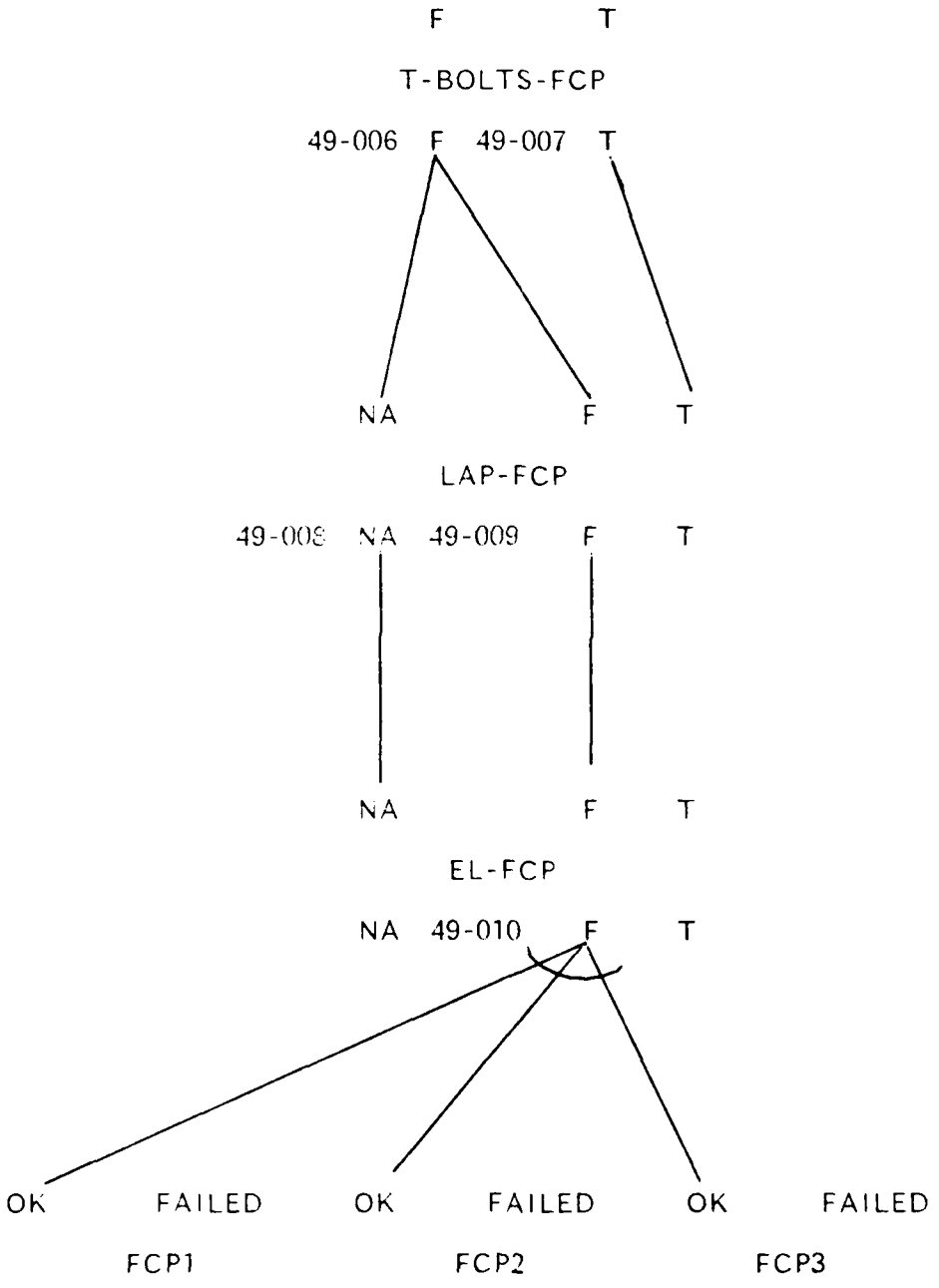
FLIGHT CONTROL PUMP



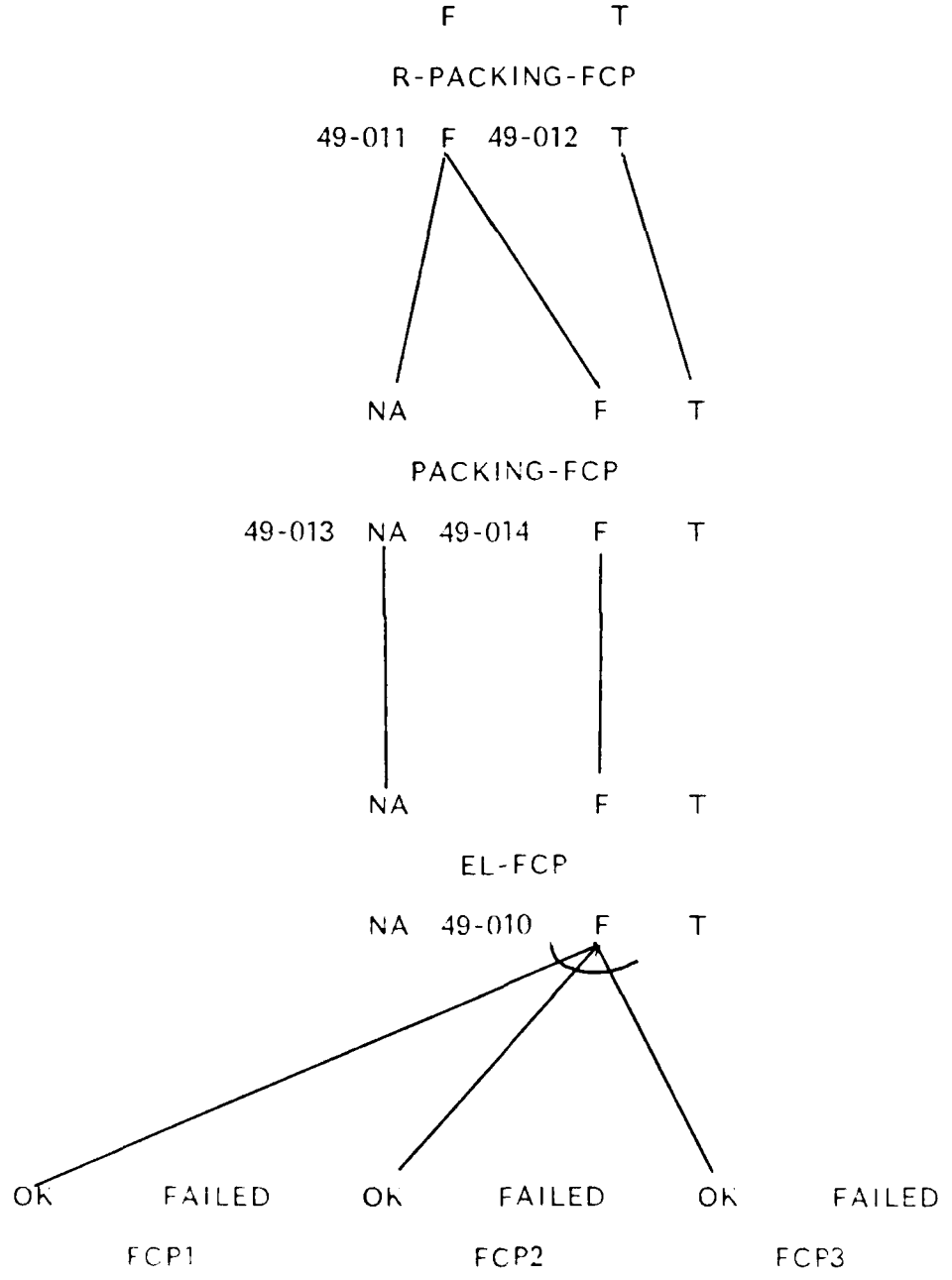
CORRECTIVE ACTIONS: FAULTY FLIGHT CONTROL PUMP
REPLACE SEALS #4



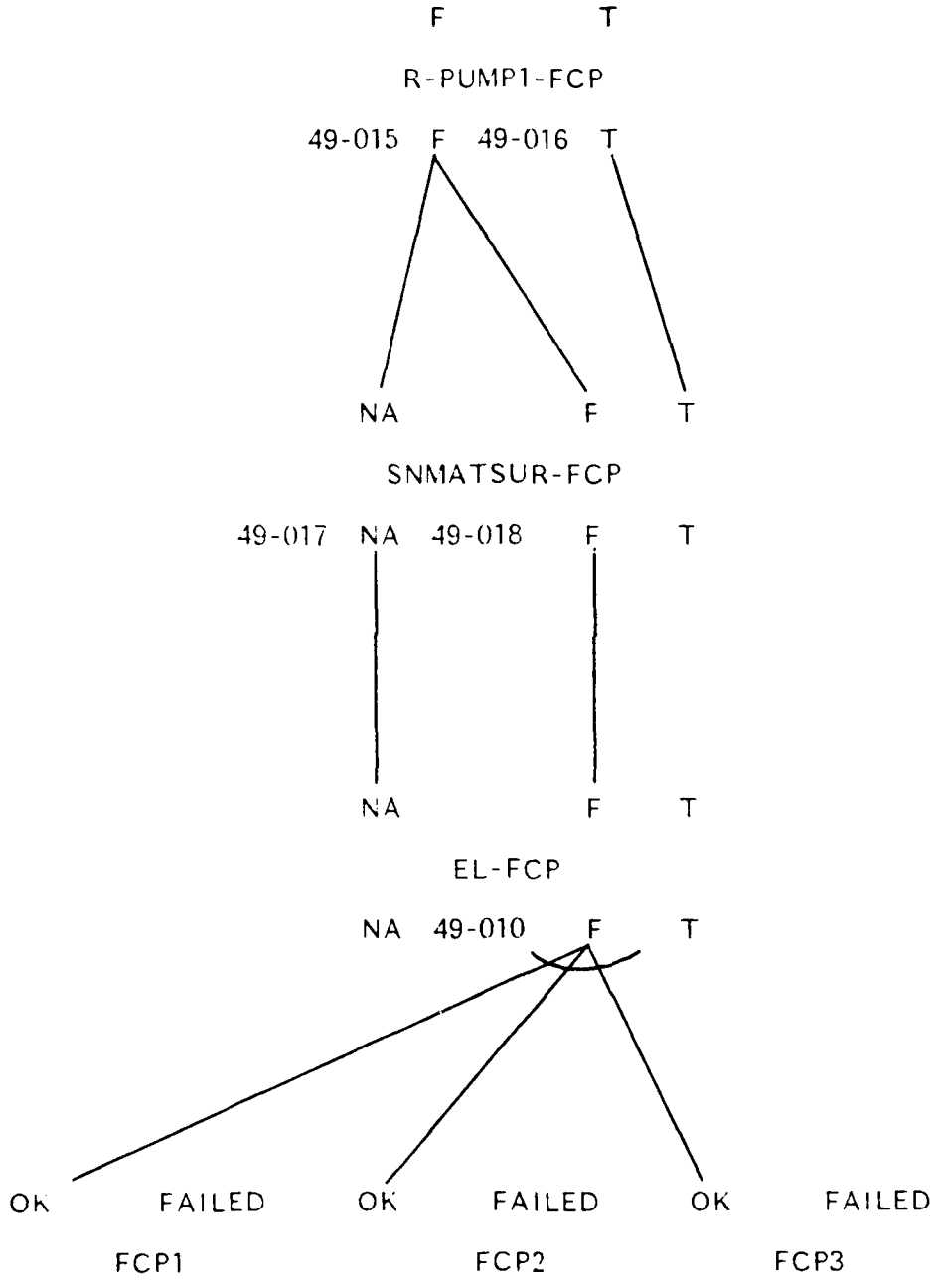
CORRECTIVE ACTIONS: FAULTY FLIGHT CONTROL PUMP
TIGHTEN BOLTS OR SCREWS IN LEAKING AREAS



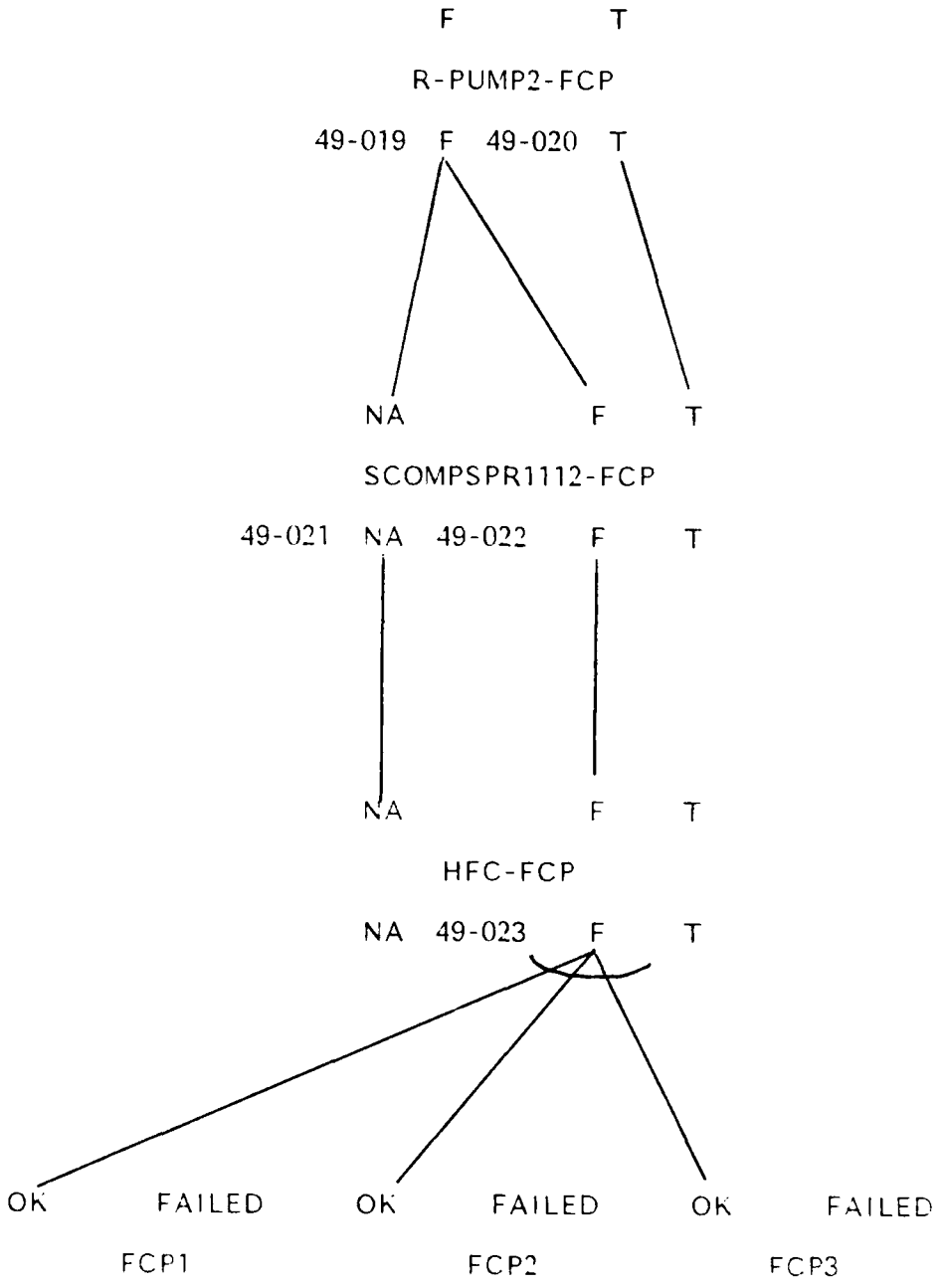
CORRECTIVE ACTIONS: FAULTY FLIGHT CONTROL PUMP
REPLACE THE PACKINGS



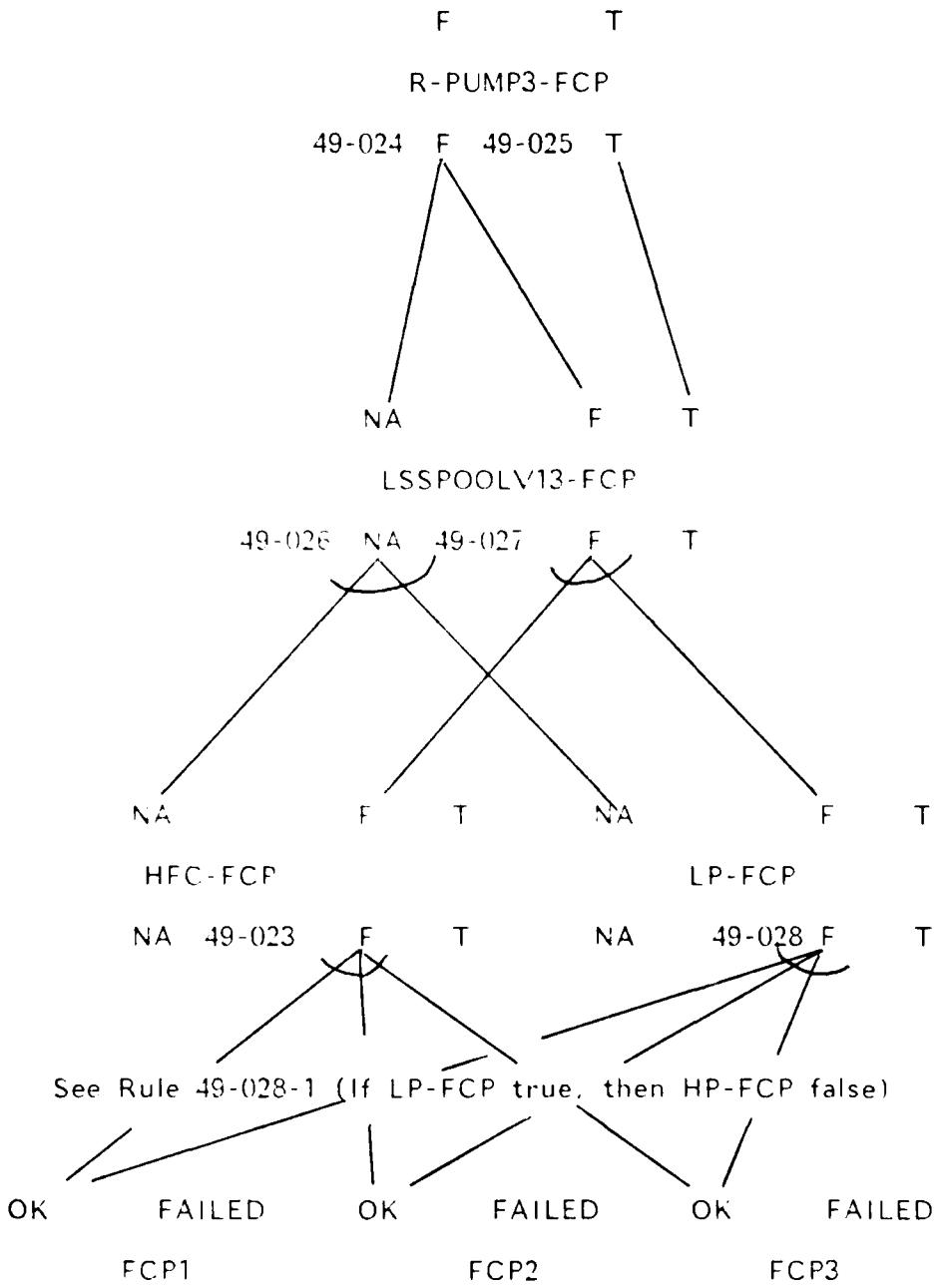
CORRECTIVE ACTIONS: FAULTY FLIGHT CONTROL PUMP
REPLACE THE PUMPS



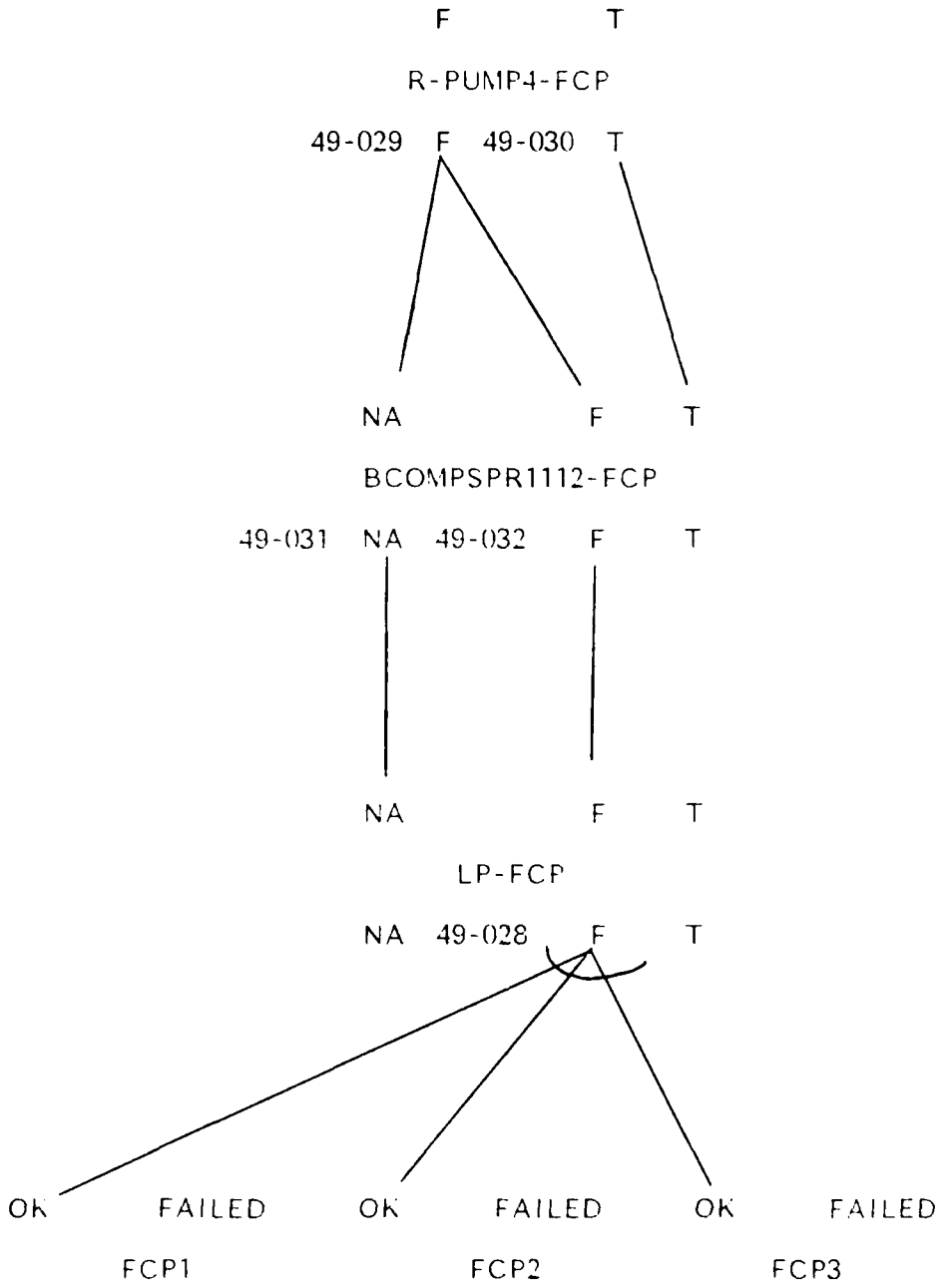
CORRECTIVE ACTIONS: FAULTY FLIGHT CONTROL PUMP
REPLACE THE PUMPS



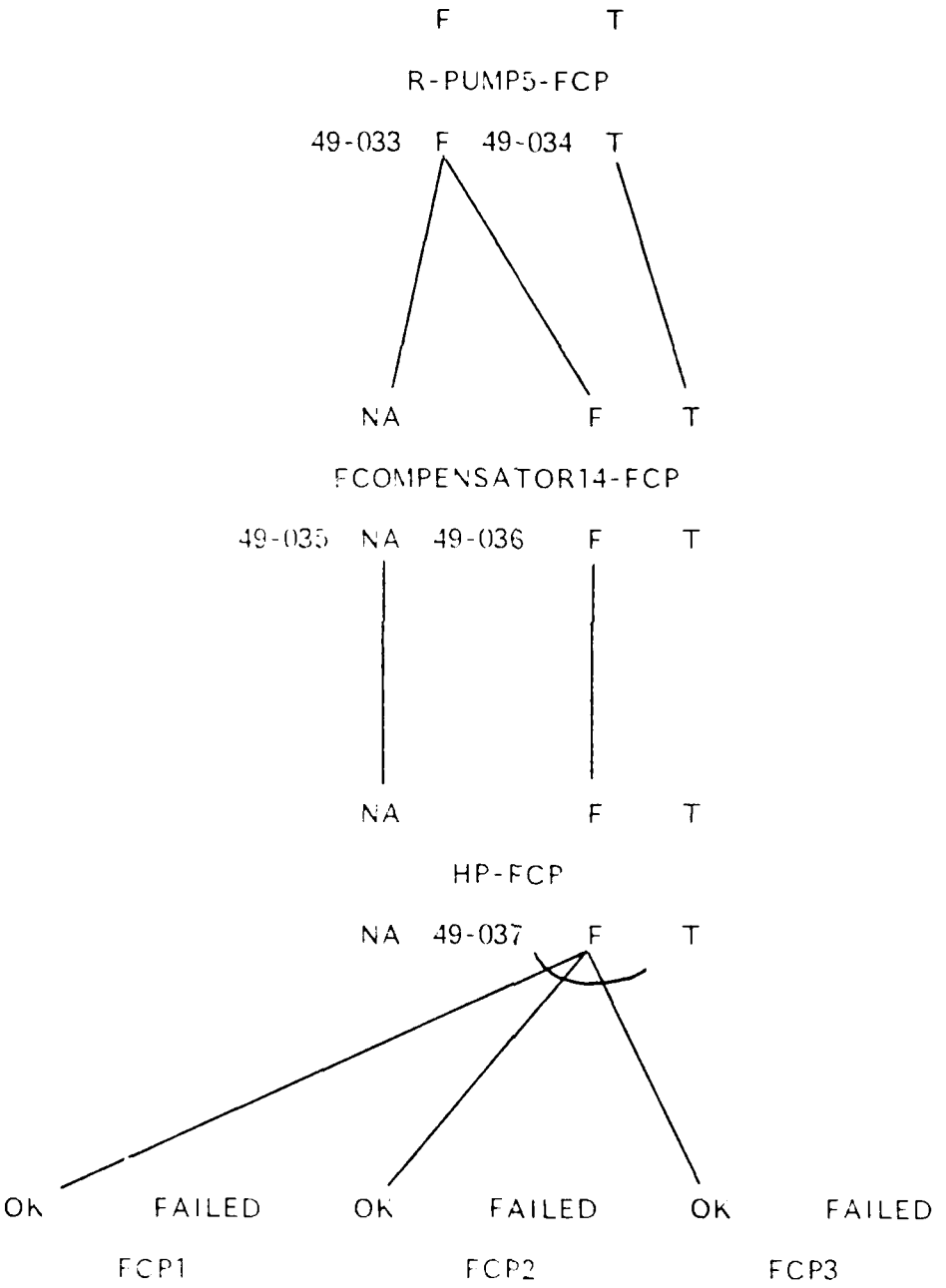
CORRECTIVE ACTIONS: FAULTY FLIGHT CONTROL PUMP
REPLACE THE PUMPS

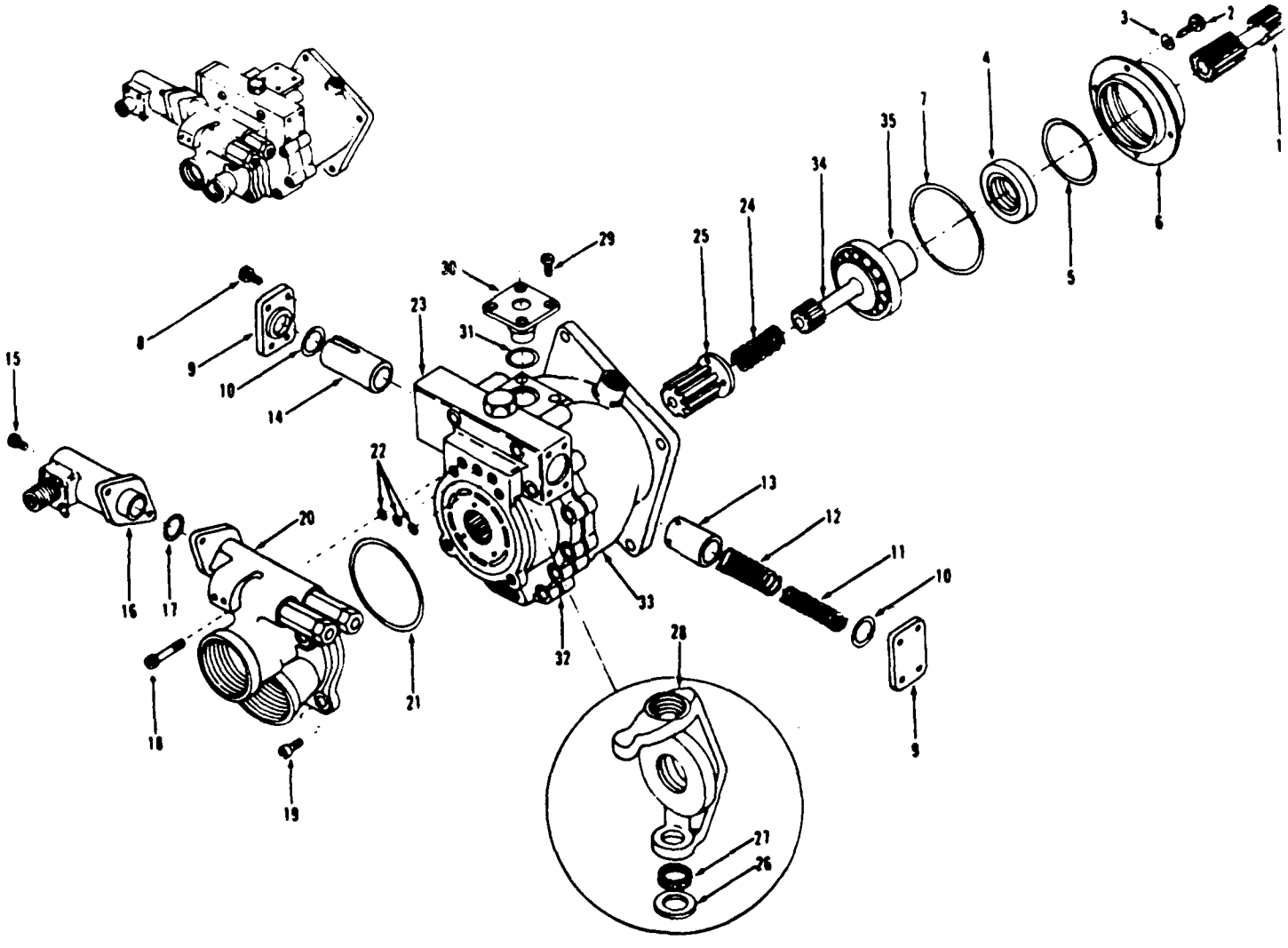


CORRECTIVE ACTIONS: FAULTY FLIGHT CONTROL PUMP
REPLACE THE PUMPS



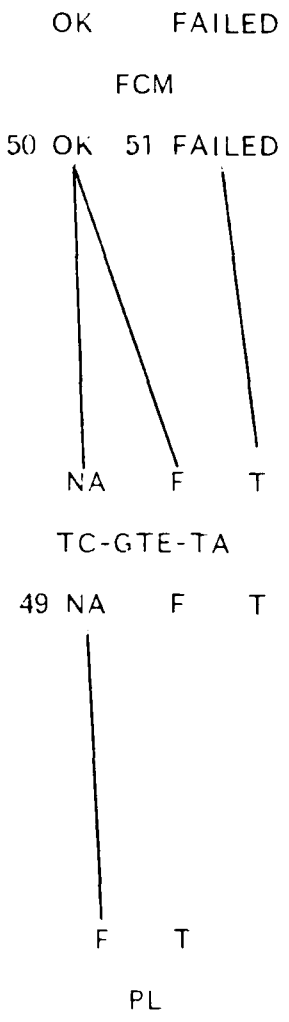
CORRECTIVE ACTIONS: FAULTY FLIGHT CONTROL PUMP
REPLACE THE PUMPS



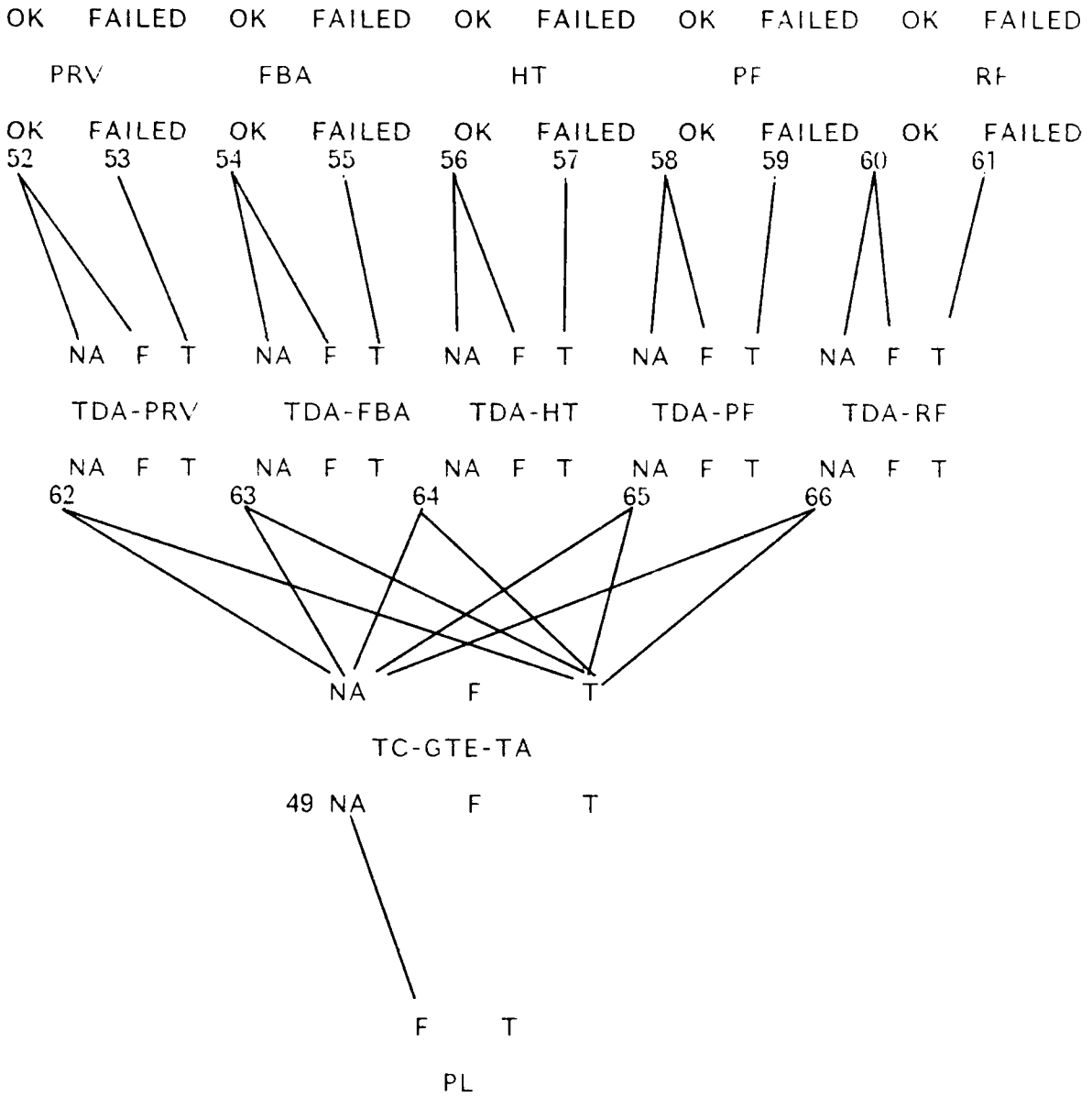


FLIGHT CONTROL SYSTEM HYDRAULIC PUMP
FIGURE 10

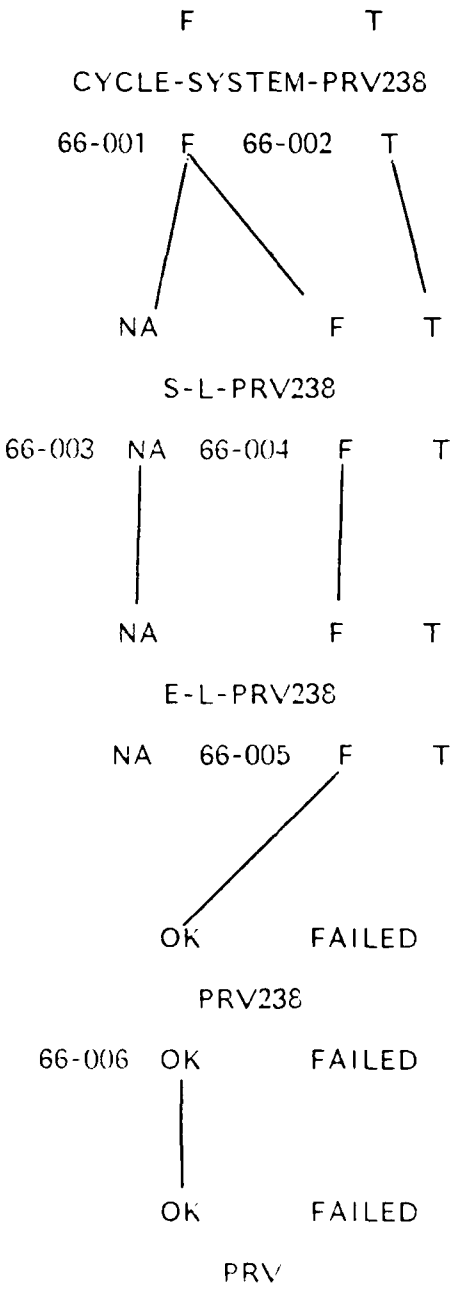
FLIGHT CONTROL MANIFOLD



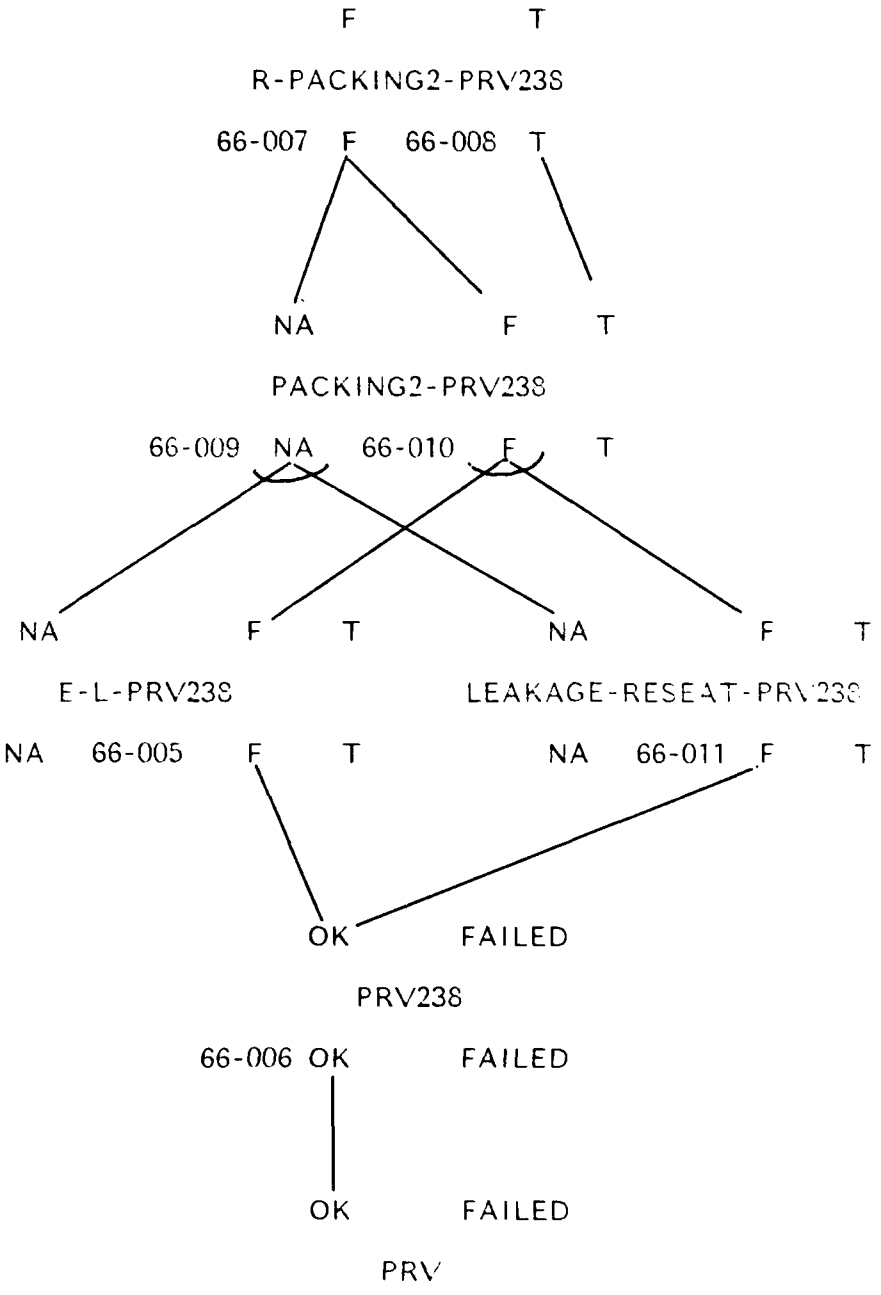
COMPONENT LEAKAGES



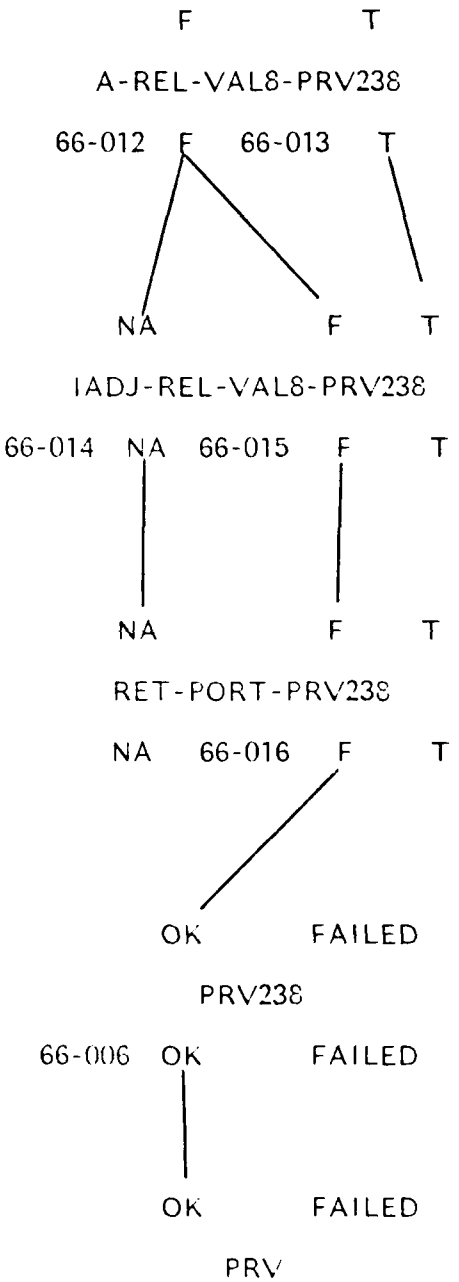
CORRECTIVE ACTIONS: FAULTY PRESSURE REDUCING VALVES 26C26602, 03, 08
CYCLE THE AFFECTED SYSTEM UNITL MOISTEN



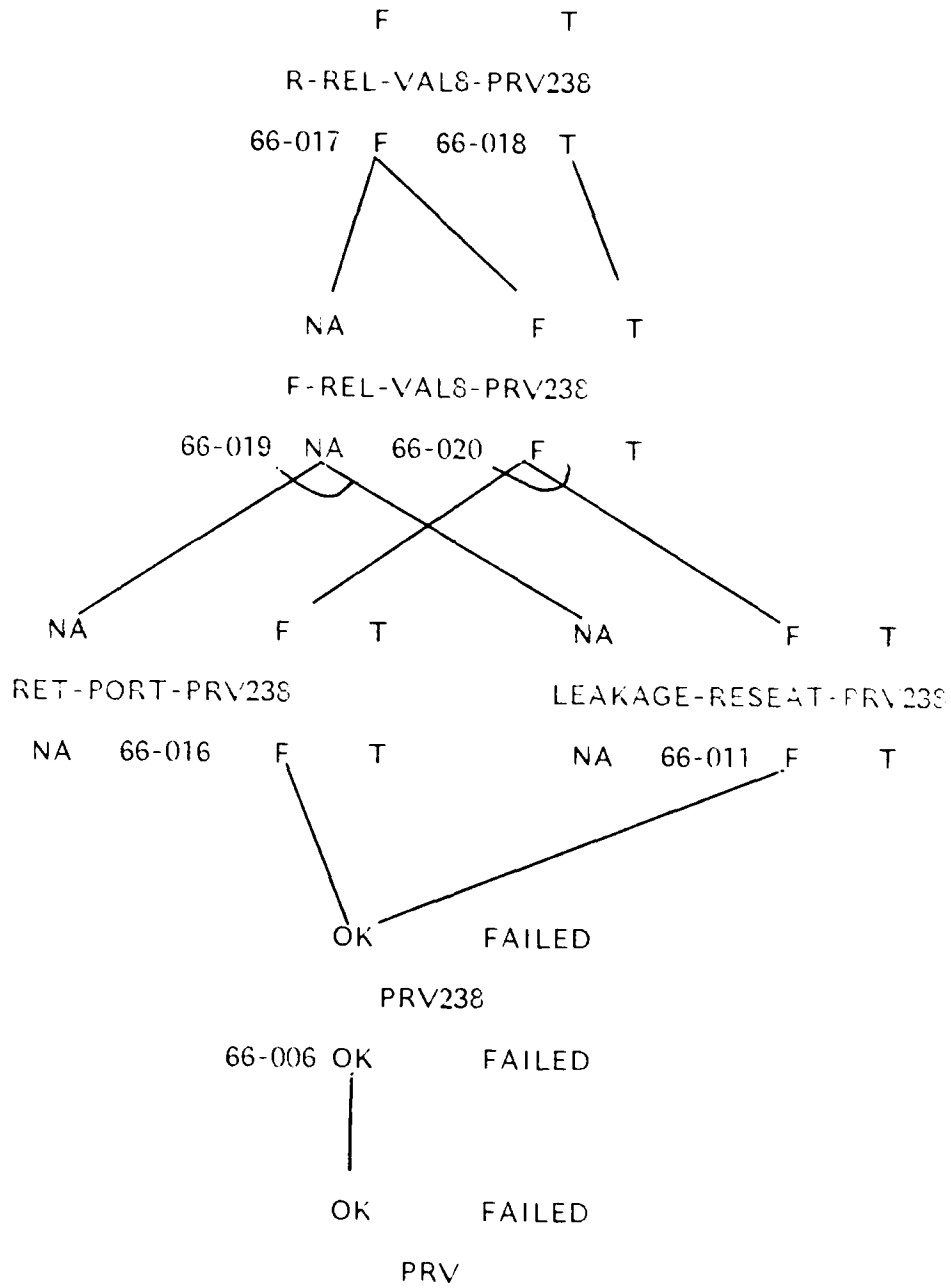
CORRECTIVE ACTIONS: FAULTY PRESSURE REDUCING VALVES 26C26602, 03, 08
REPLACE FAULTY PACKING #2



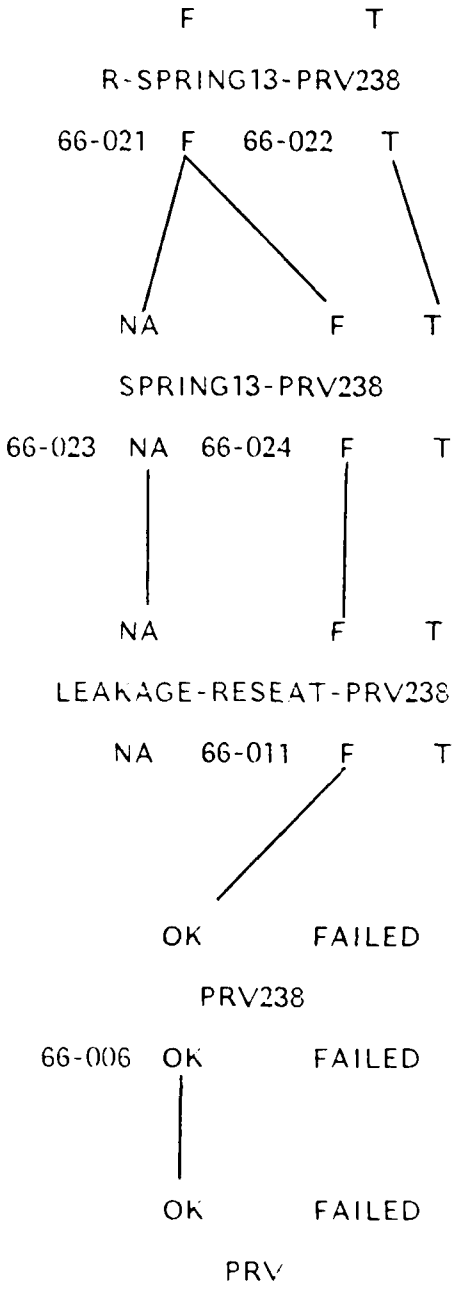
CORRECTIVE ACTIONS: FAULTY PRESSURE REDUCING VALVES 26C26602, 03, 08
ADJUST RELIEF VALVE #8



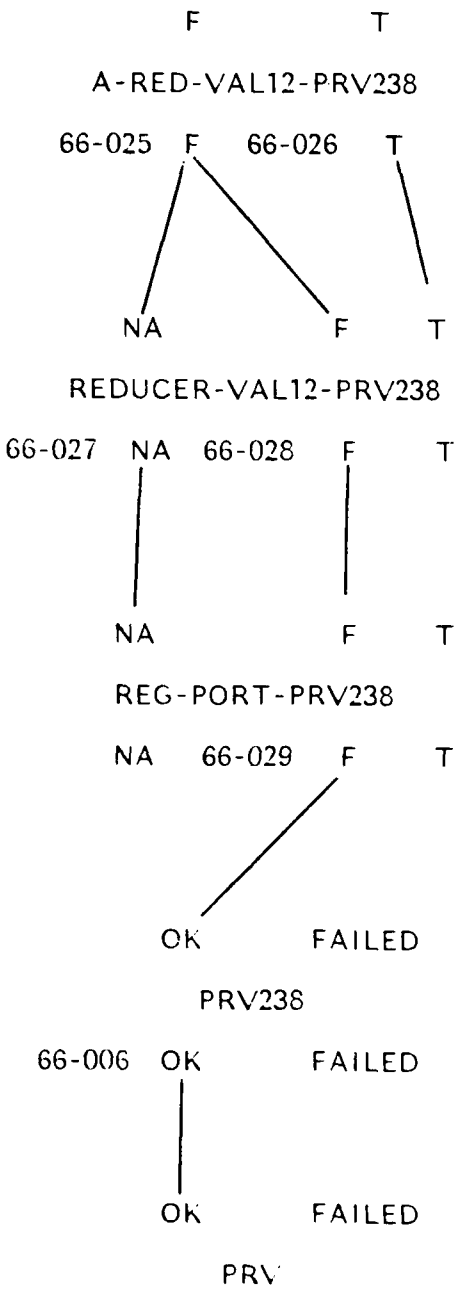
CORRECTIVE ACTIONS: FAULTY PRESSURE REDUCING VALVES 26C26602, 03, 08
REPLACE RELIEF VALVE #8 ASSEMBLY AS A MATCHED SET



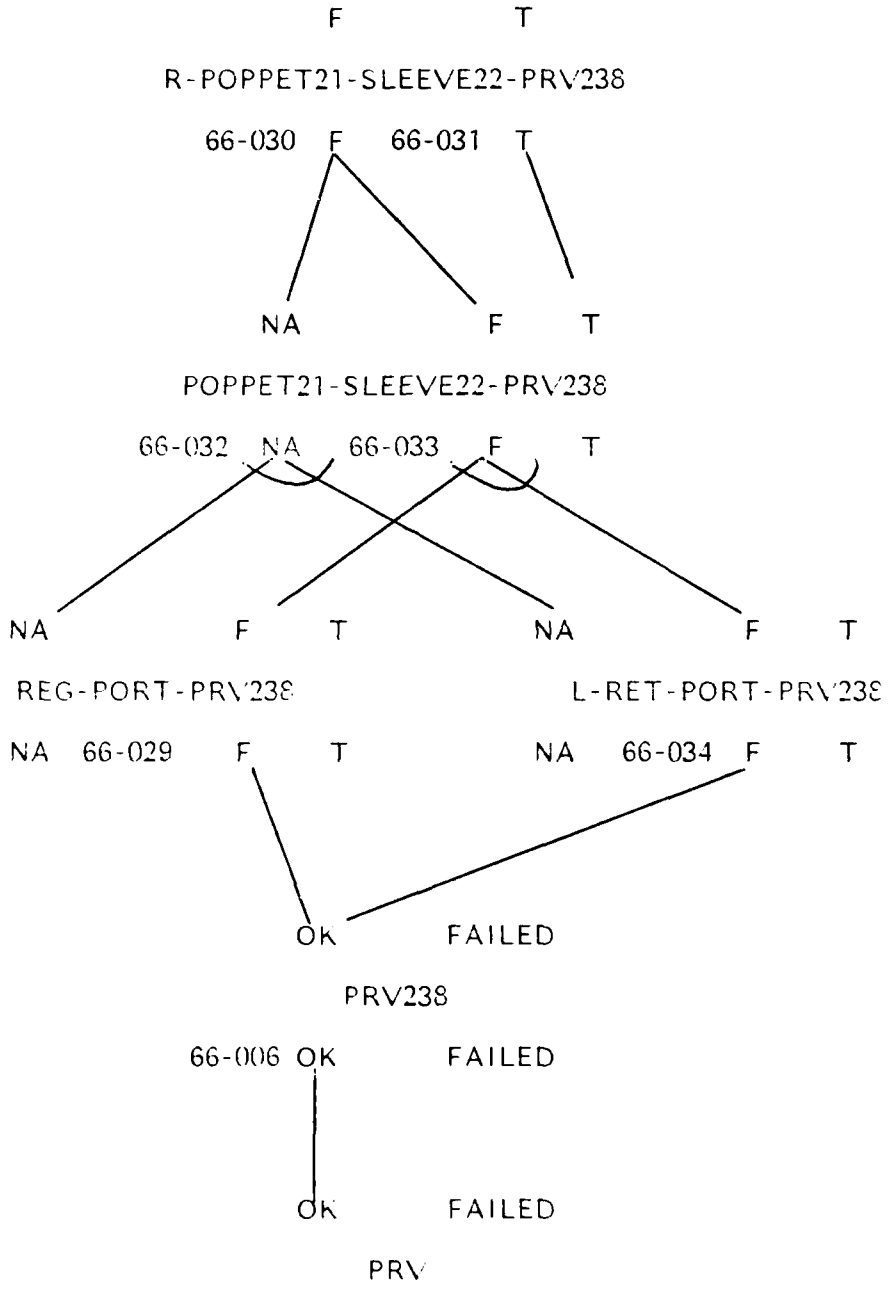
CORRECTIVE ACTIONS: FAULTY PRESSURE REDUCING VALVES 26C26602, 03, 08
REPLACE SPRING #13



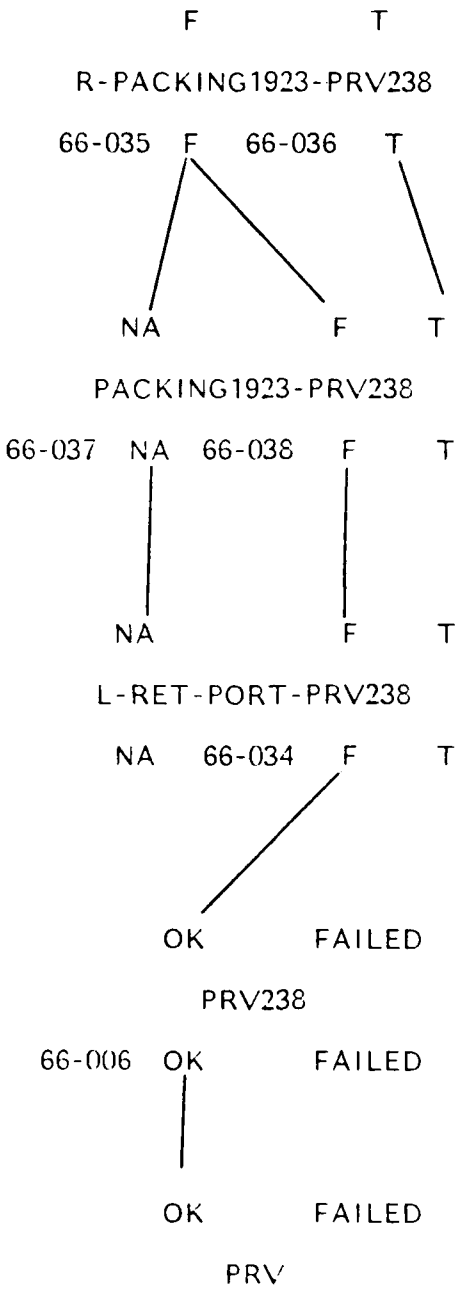
CORRECTIVE ACTIONS: FAULTY PRESSURE REDUCING VALVES 26C26602, 03, 08
ADJUST REDUCER VALVE #12

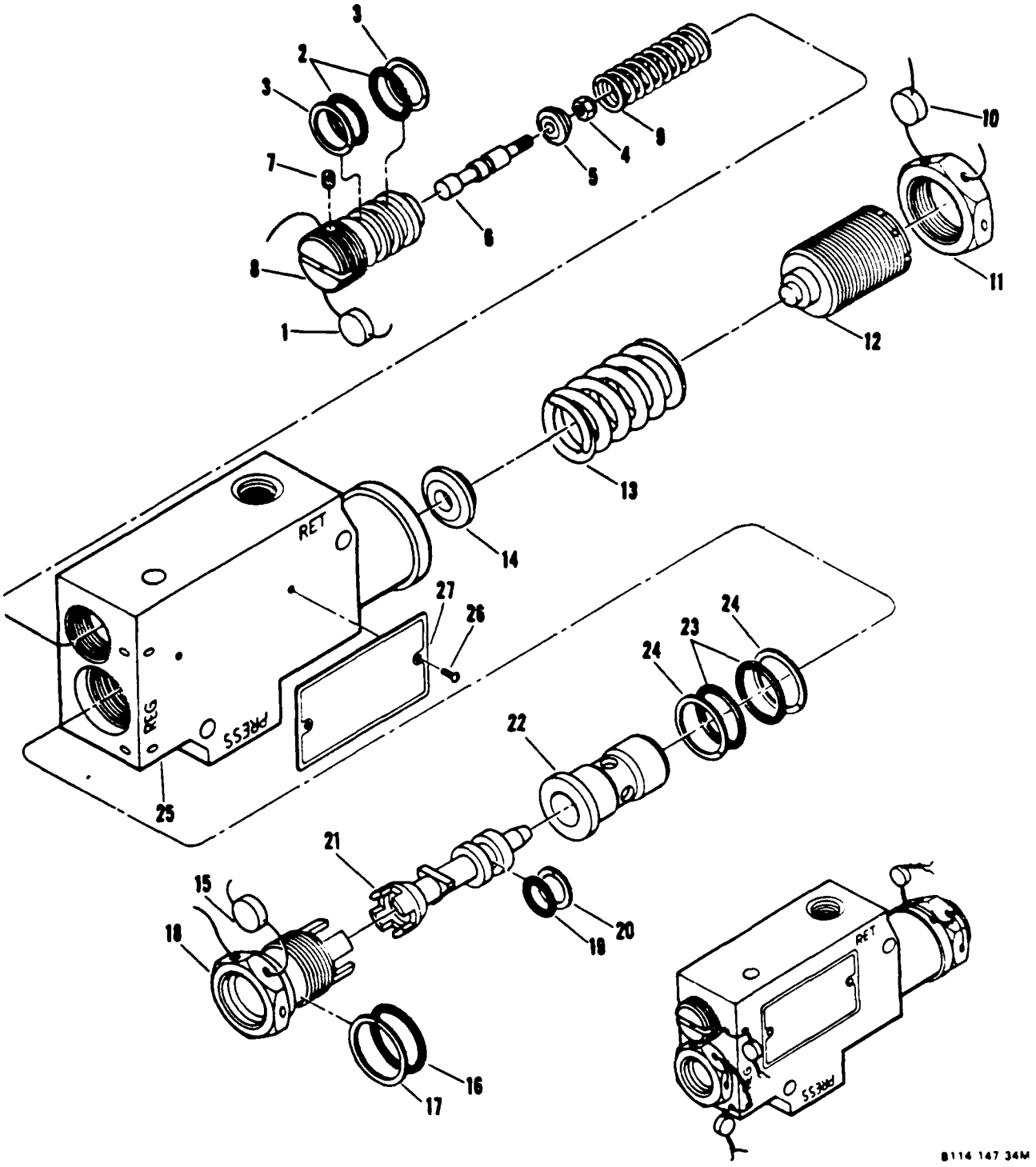


CORRECTIVE ACTIONS: FAULTY PRESSURE REDUCING VALVES 26C26602, 03, 08
REPLACE POPPET #21 AND SLEEVE #22 AS A MATCHED SET



CORRECTIVE ACTIONS: FAULTY PRESSURE REDUCING VALVES 26C26602, 03, 08
REPLACE PACKINGS #19 AND #23

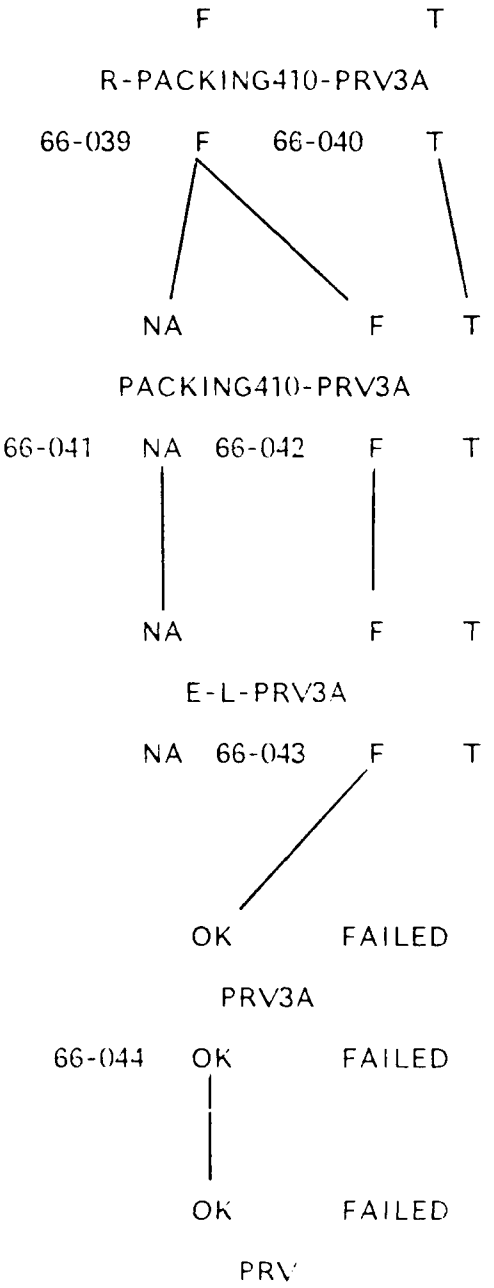




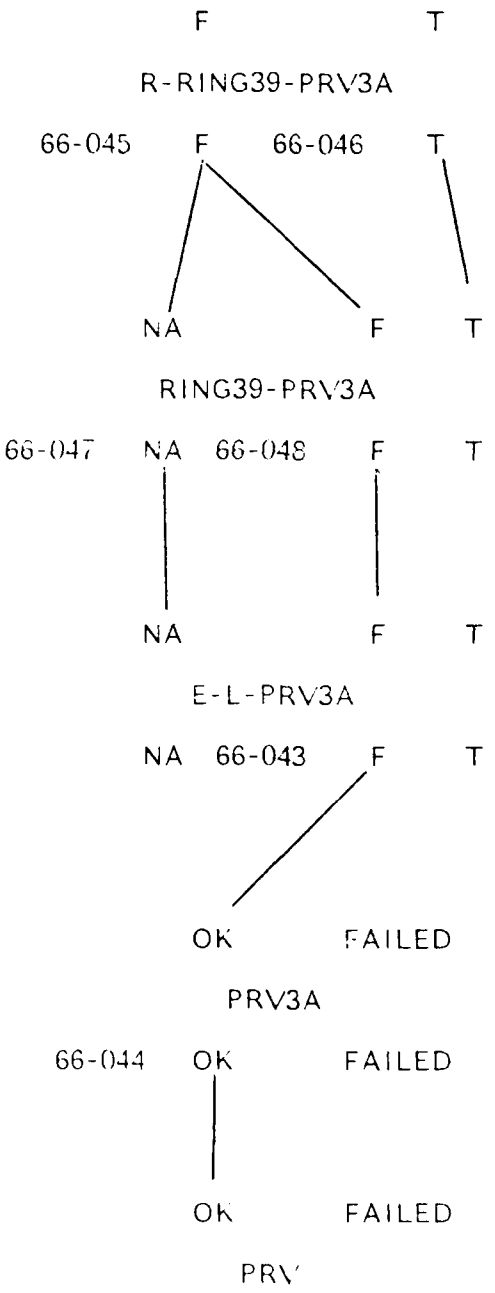
1. Seal	10. Seal	19. Packing
2. Packing	11. Nut	20. Retainer
3. Retainer	12. Adjusting screw	21. Popper
4. Nut	13. Spring	22. Sleeve
5. Seat	14. Seat	23. Packing
6. Spool	15. Seal	24. Retainer
7. Insert	16. Packing	25. Body
8. Relief valve body	17. Retainer	26. Screw
9. Spring	18. Gland	27. Nameplate

PRESSURE REDUCING VALVES 26C26602 AND 26C26608
FIGURE 11

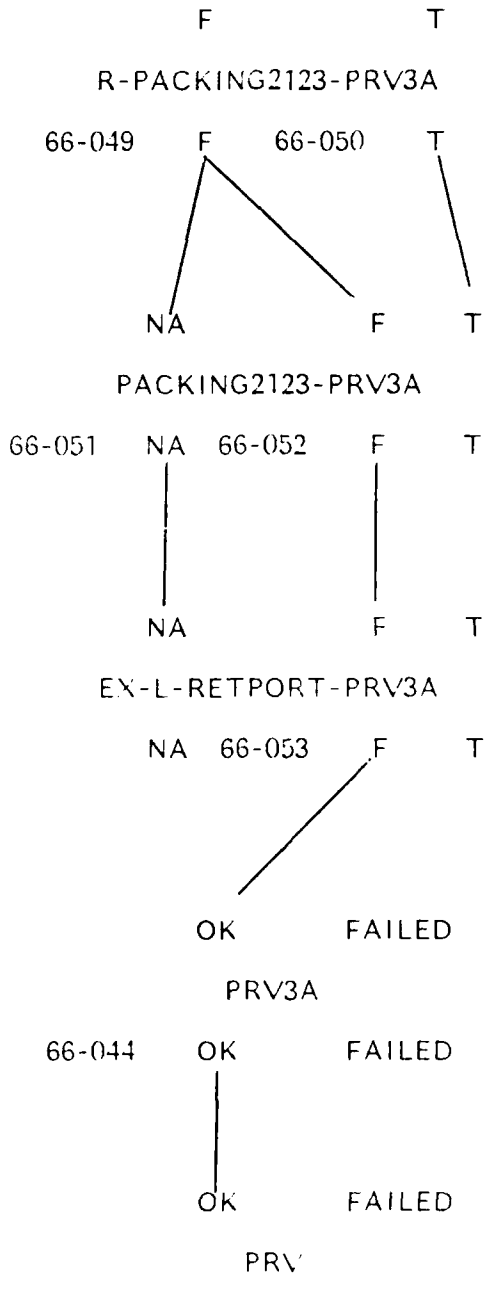
CORRECTIVE ACTIONS: FAULTY PRESSURE REDUCING VALVES 3A011
REPLACE PACKINGS #4 AND #20



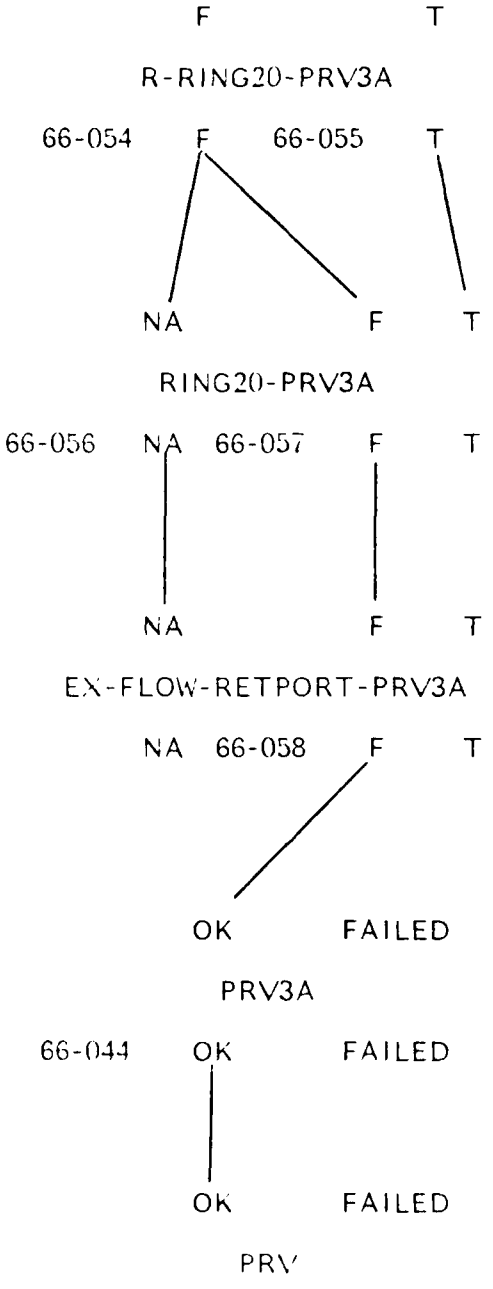
CORRECTIVE ACTIONS: FAULTY PRESSURE REDUCING VALVES 3A011
REMOVE AND REASSEMBLE BACKUP RING #3 OR #9



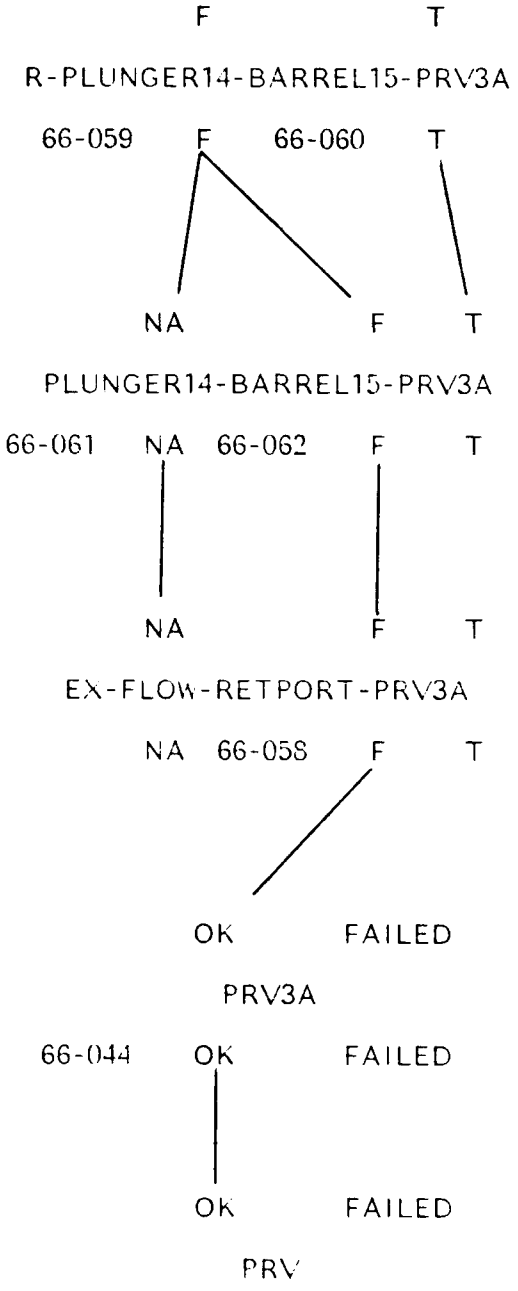
CORRECTIVE ACTIONS: FAULTY PRESSURE REDUCING VALVES 3A011
REPLACE PACKINGS #21 AND #23



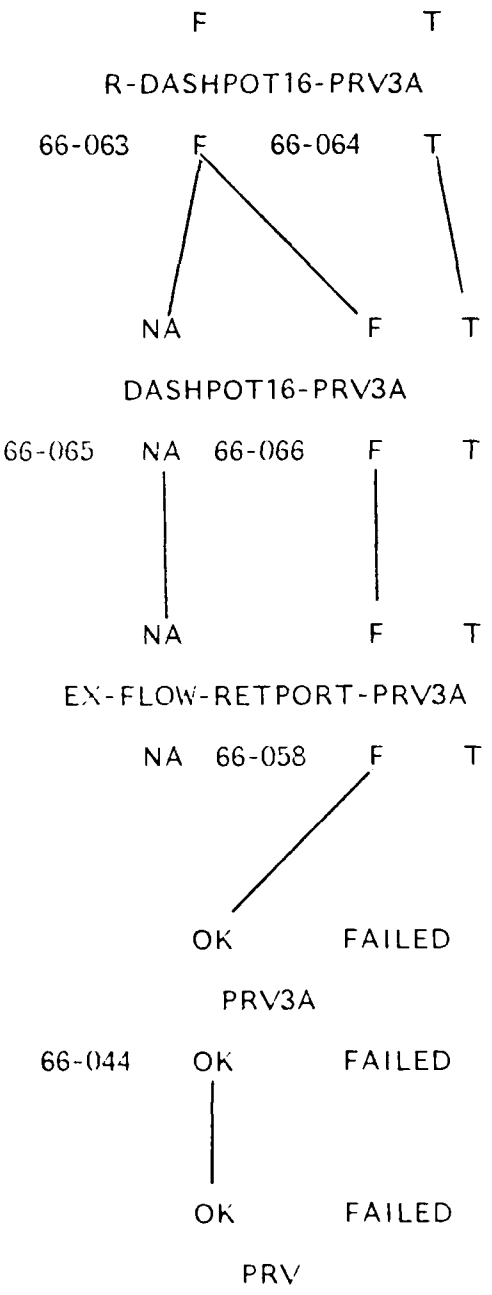
CORRECTIVE ACTIONS: FAULTY PRESSURE REDUCING VALVES 3A011
REMOVE AND REASSEMBLE BACKUP RING #20



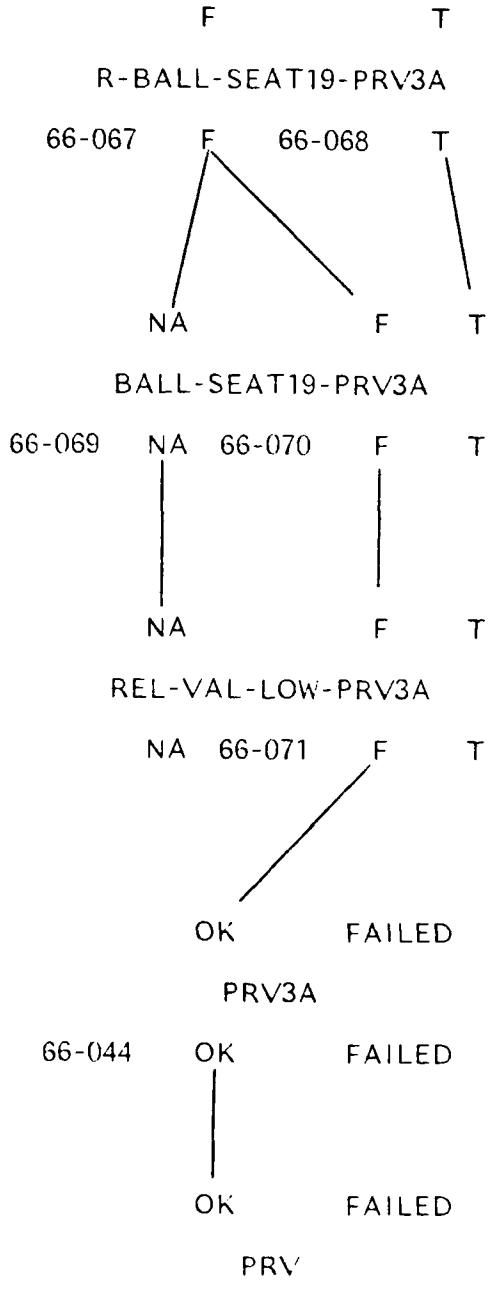
CORRECTIVE ACTIONS: FAULTY PRESSURE REDUCING VALVES 3A011
REPLACE PLUNGER #14 AND BARREL #15



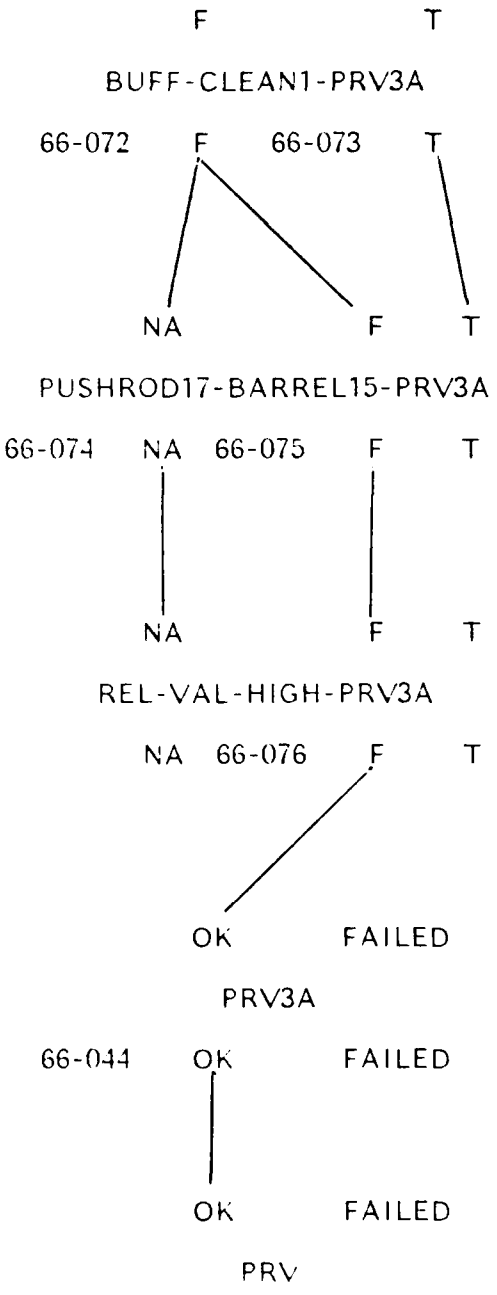
CORRECTIVE ACTIONS: FAULTY PRESSURE REDUCING VALVES 3A011
REMOVE AND REASSEMBLE DASHPOT #16



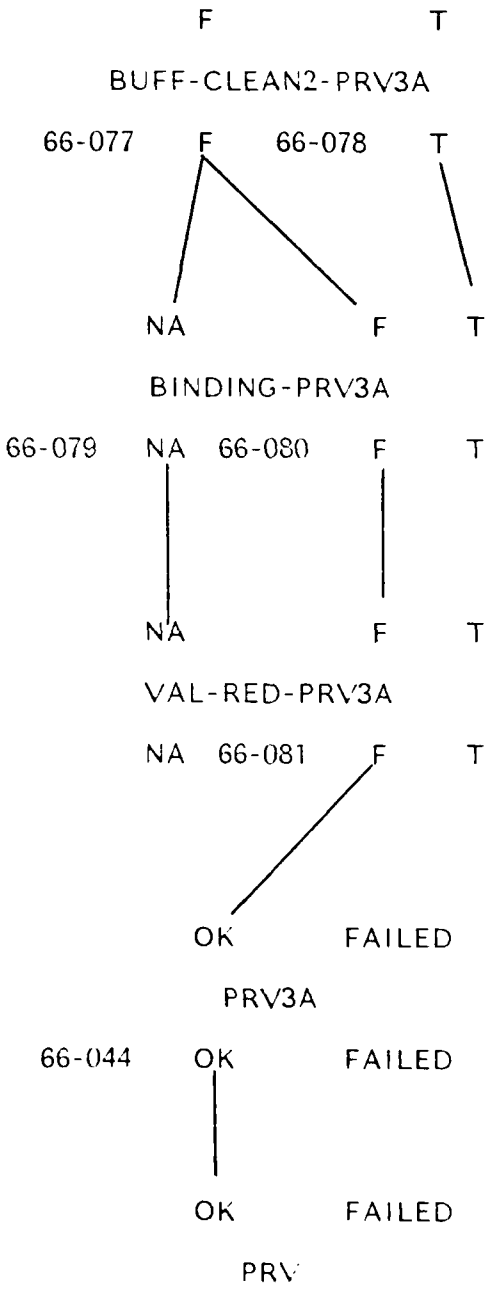
CORRECTIVE ACTIONS: FAULTY PRESSURE REDUCING VALVES 3A011
RESEAT OR REPLACE BALL SEAT #19



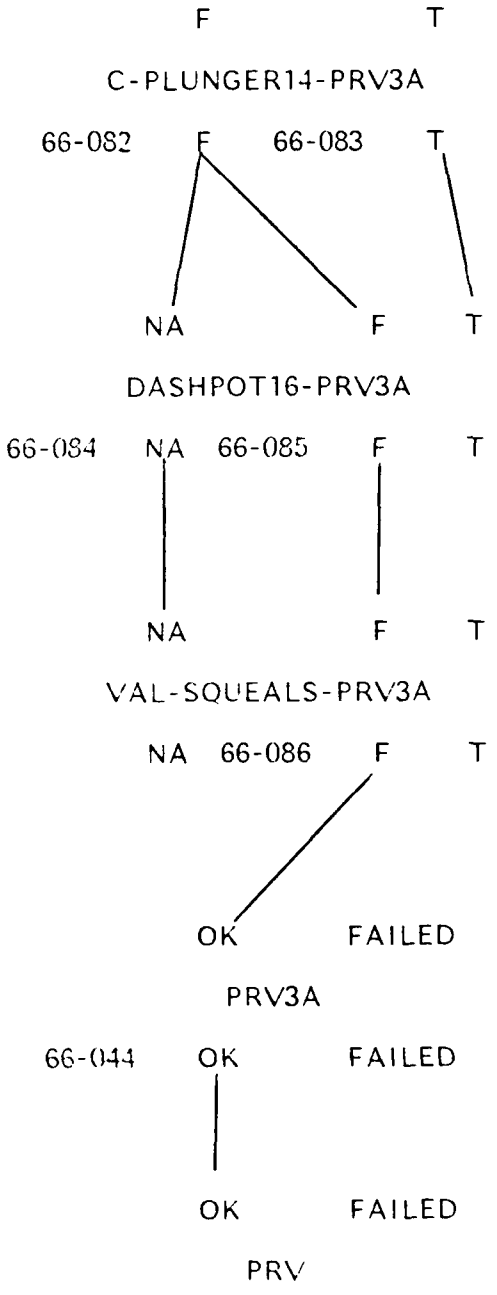
CORRECTIVE ACTIONS: FAULTY PRESSURE REDUCING VALVES 3A011
BUFF AND CLEAN PUSHROD #17 AND BARREL #15 AND CHECK FOR SMOOTH FIT



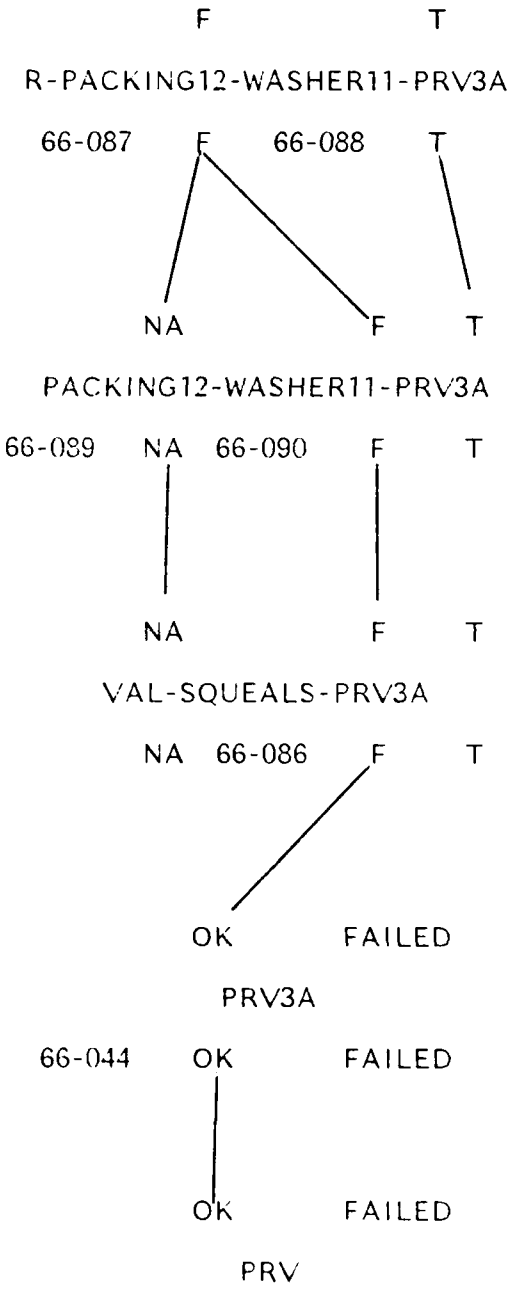
CORRECTIVE ACTIONS: FAULTY PRESSURE REDUCING VALVES 3A011
BUFF AND CLEAN PUSHROD #17 AND BARREL #15 AND CHECK FOR SMOOTH FIT



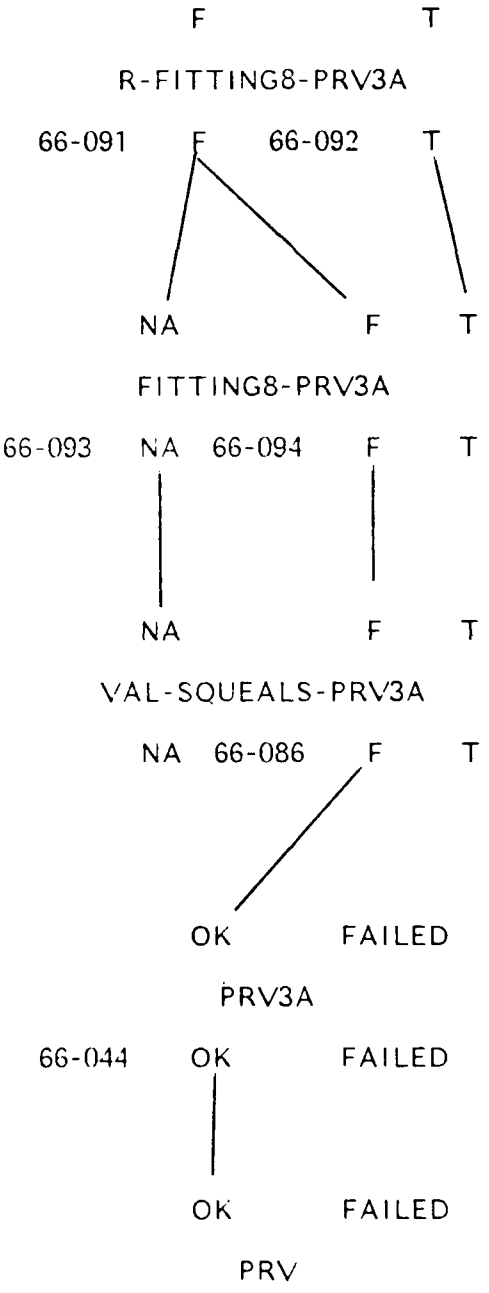
CORRECTIVE ACTIONS: FAULTY PRESSURE REDUCING VALVES 3A011
CHECK FOR FREE FIT WITH PLUNGER #14 AND REASSEMBLE

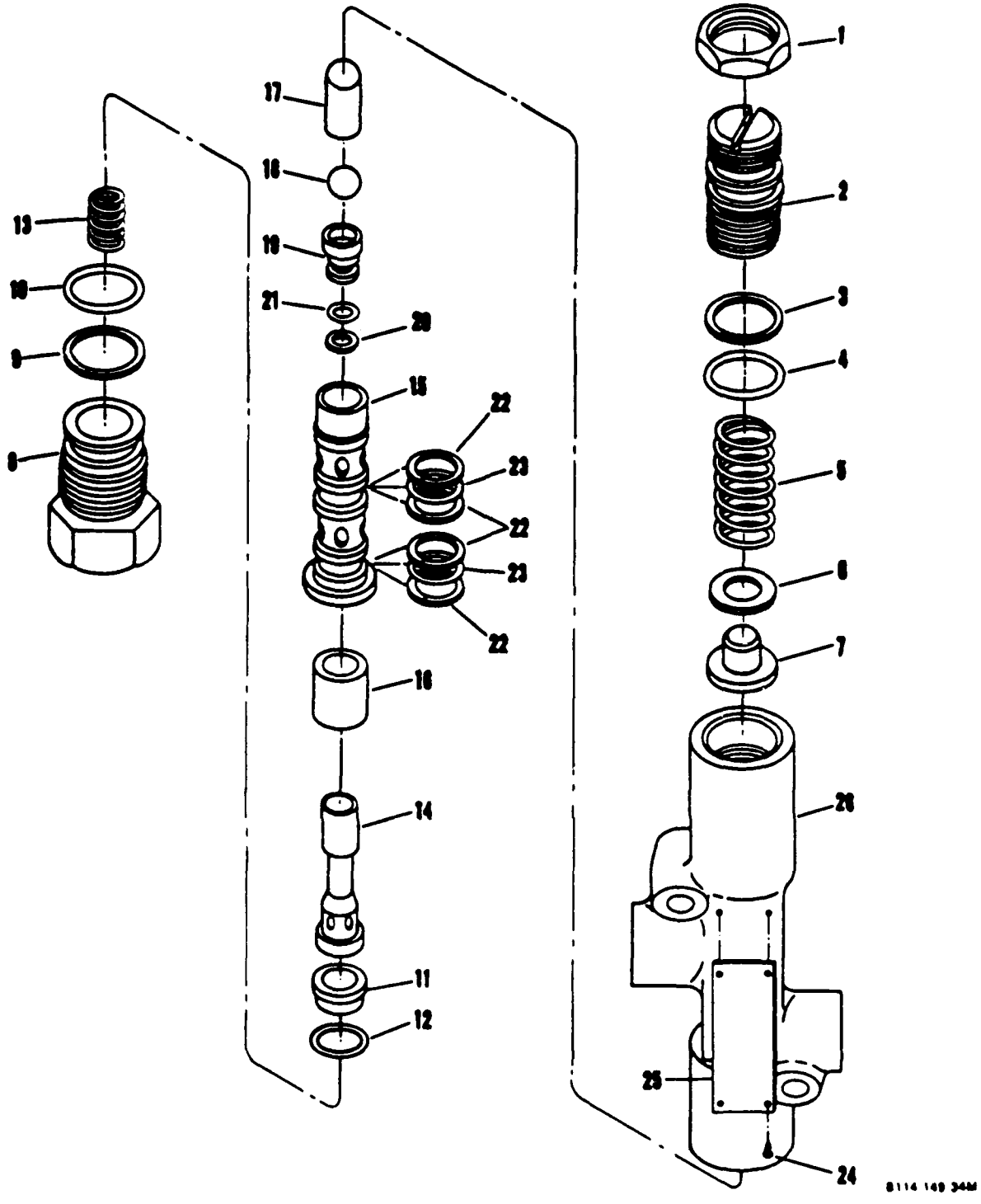


CORRECTIVE ACTIONS: FAULTY PRESSURE REDUCING VALVES 3A011
REMOVE AND REASSEMBLE PACKING #12 AND WASHER #11



CORRECTIVE ACTIONS: FAULTY PRESSURE REDUCING VALVES 3A011
UNSCREW AND RETORQUE FITTING #8 TO 250 POUND-INCHES

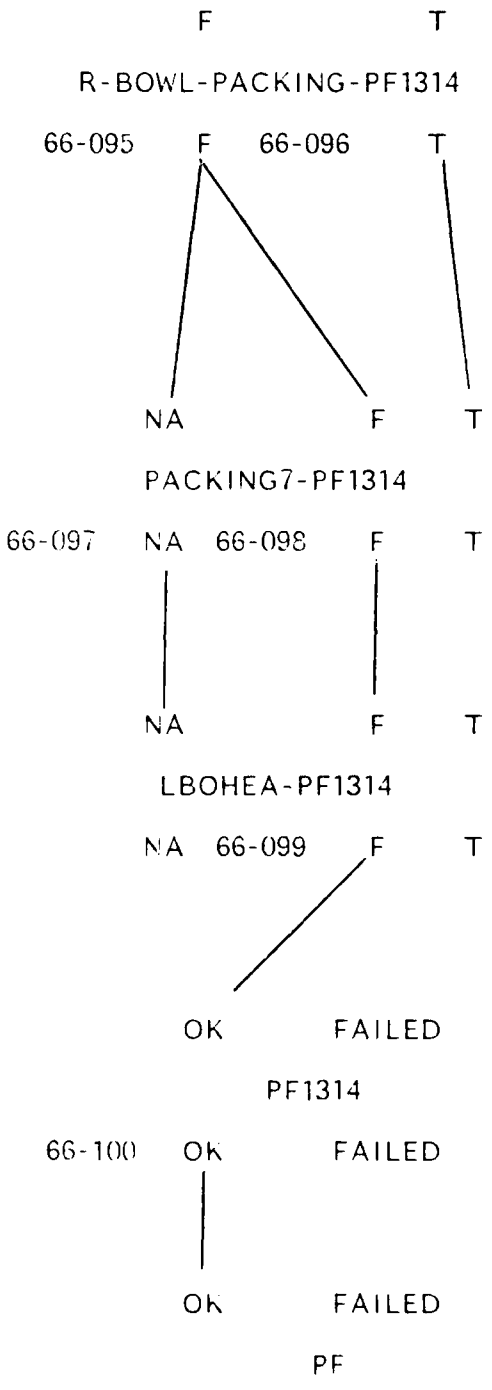




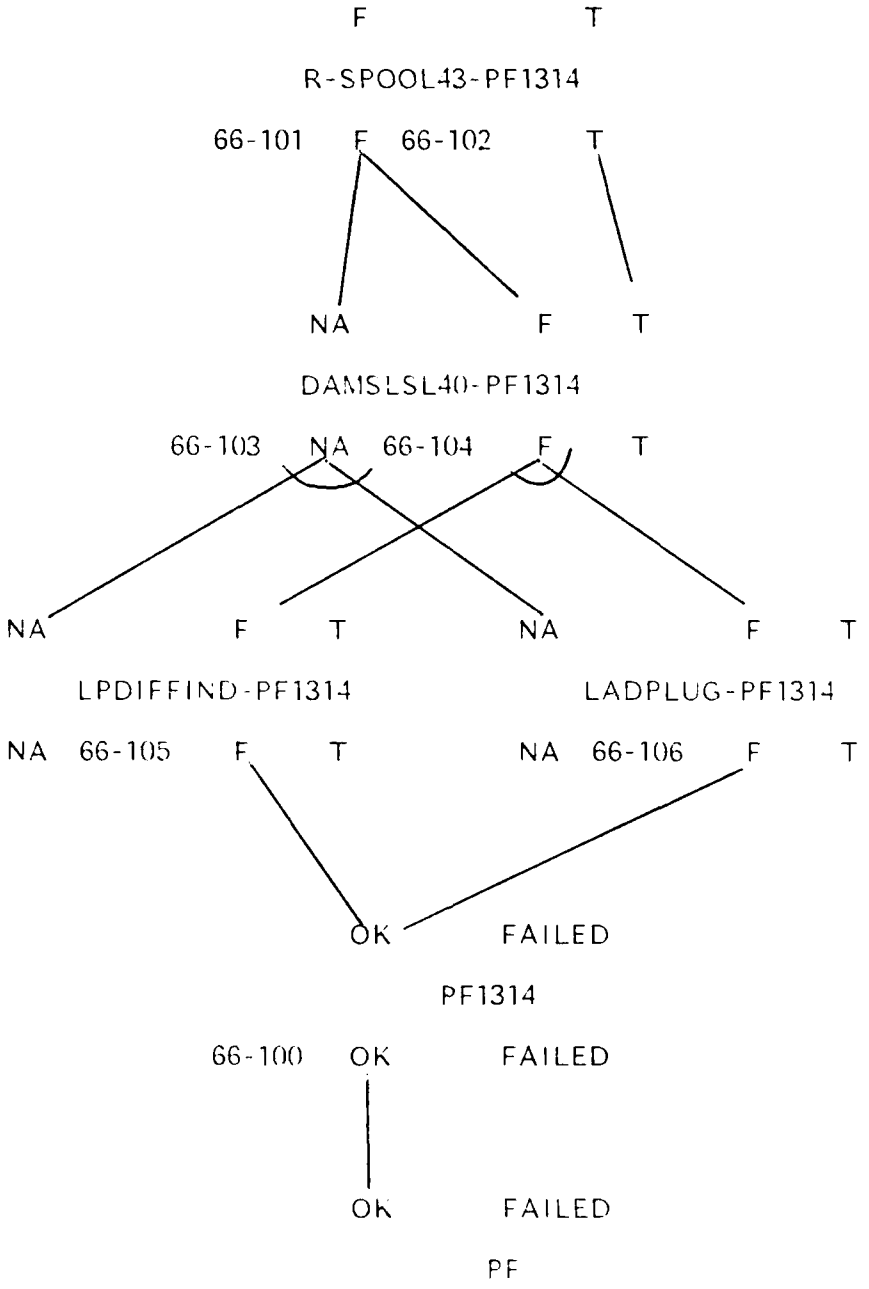
1. Locknut
2. Rod cap
3. Backup ring
4. Packing
5. Spring
6. Washer
7. Retainer
8. Fitting
9. Backup ring
10. Packing
11. Washer
12. Packing
13. Spring
14. Plunger
15. Barrel
16. Dashpot
17. Pushrod
18. Ball
19. Seat
20. Backup ring
21. Packing
22. Backup ring
23. Packing
24. Screw
25. Nameplate
26. Body

PRESSURE REDUCING VALVES 3A011
FIGURE 12

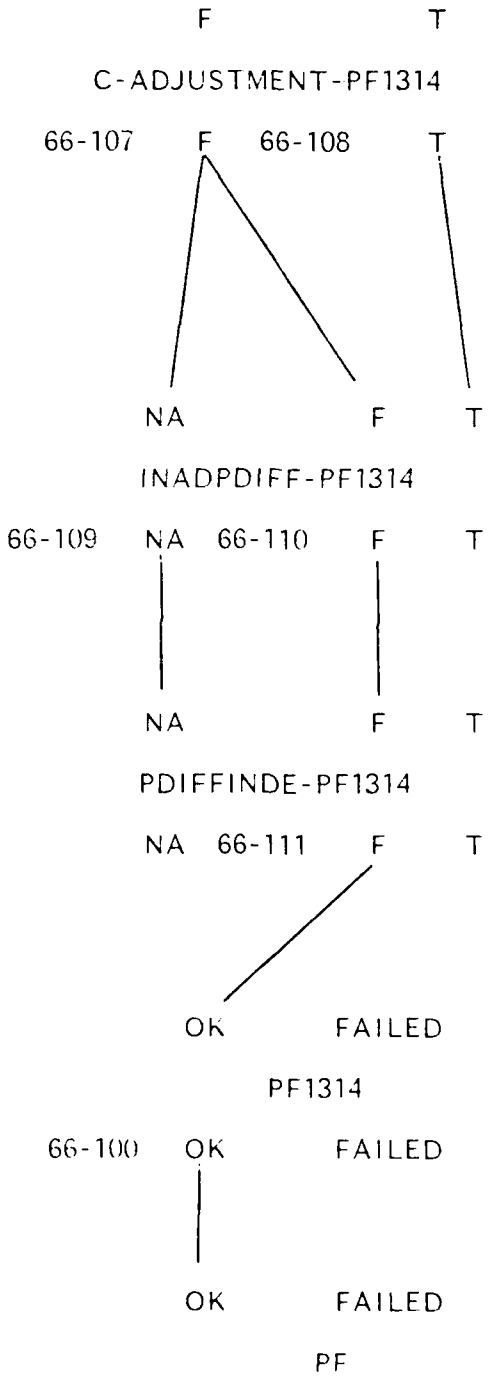
CORRECTIVE ACTIONS: FAULTY PRESSURE FILTERS 114HS120-13 AND -14
REPLACE THE PACKING AND REMOVE THE BOWL



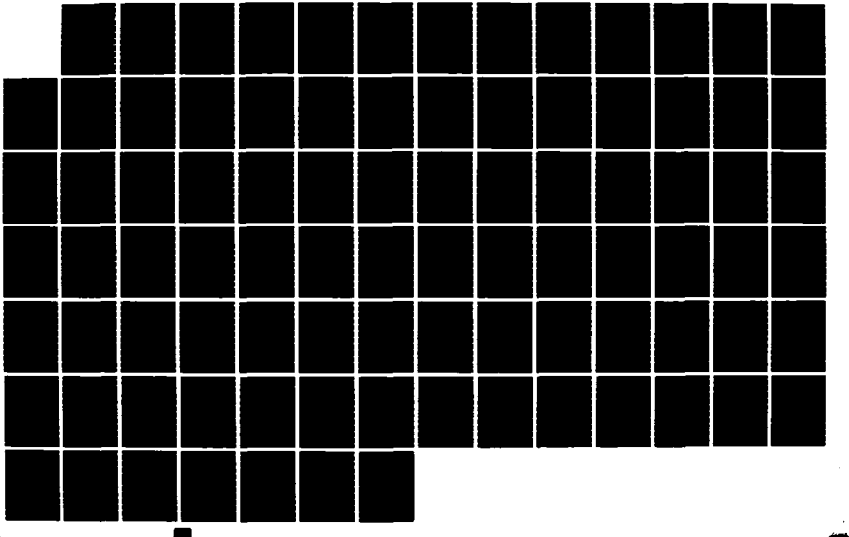
CORRECTIVE ACTIONS: FAULTY PRESSURE FILTERS 114HS120-13 AND -14 REPLACE SPOOL ASSEMBLY #43

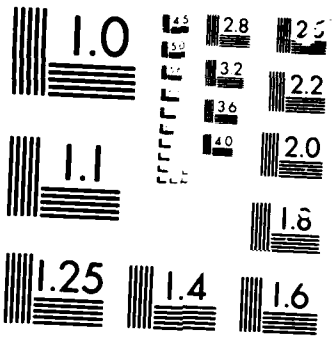


CORRECTIVE ACTIONS: FAULTY PRESSURE FILTERS 114HS120-13 AND -14
CORRECT ADJUSTMENT

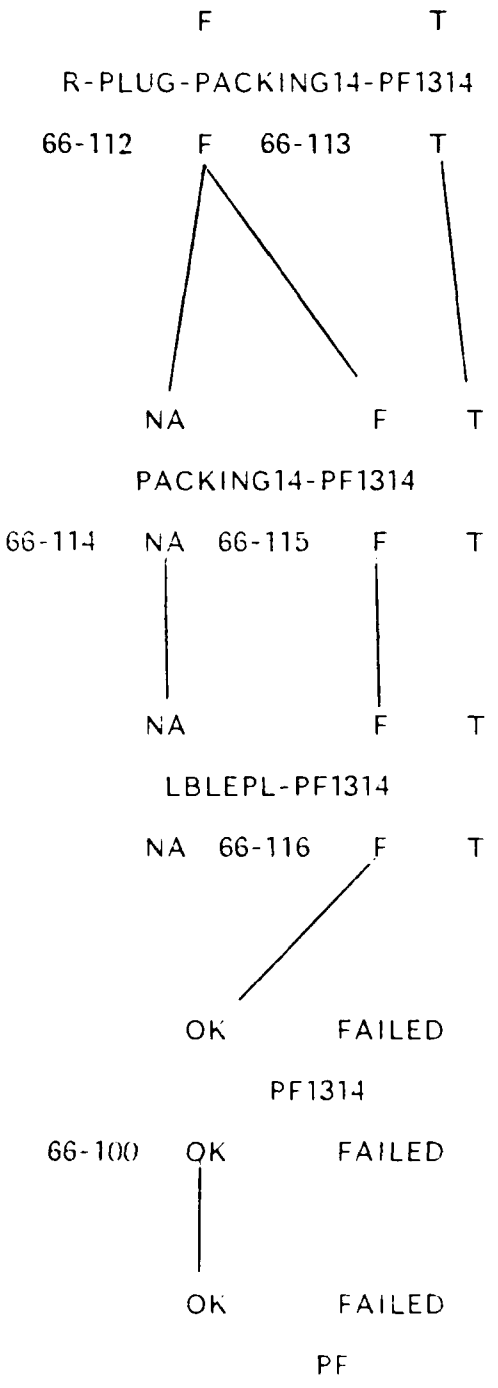


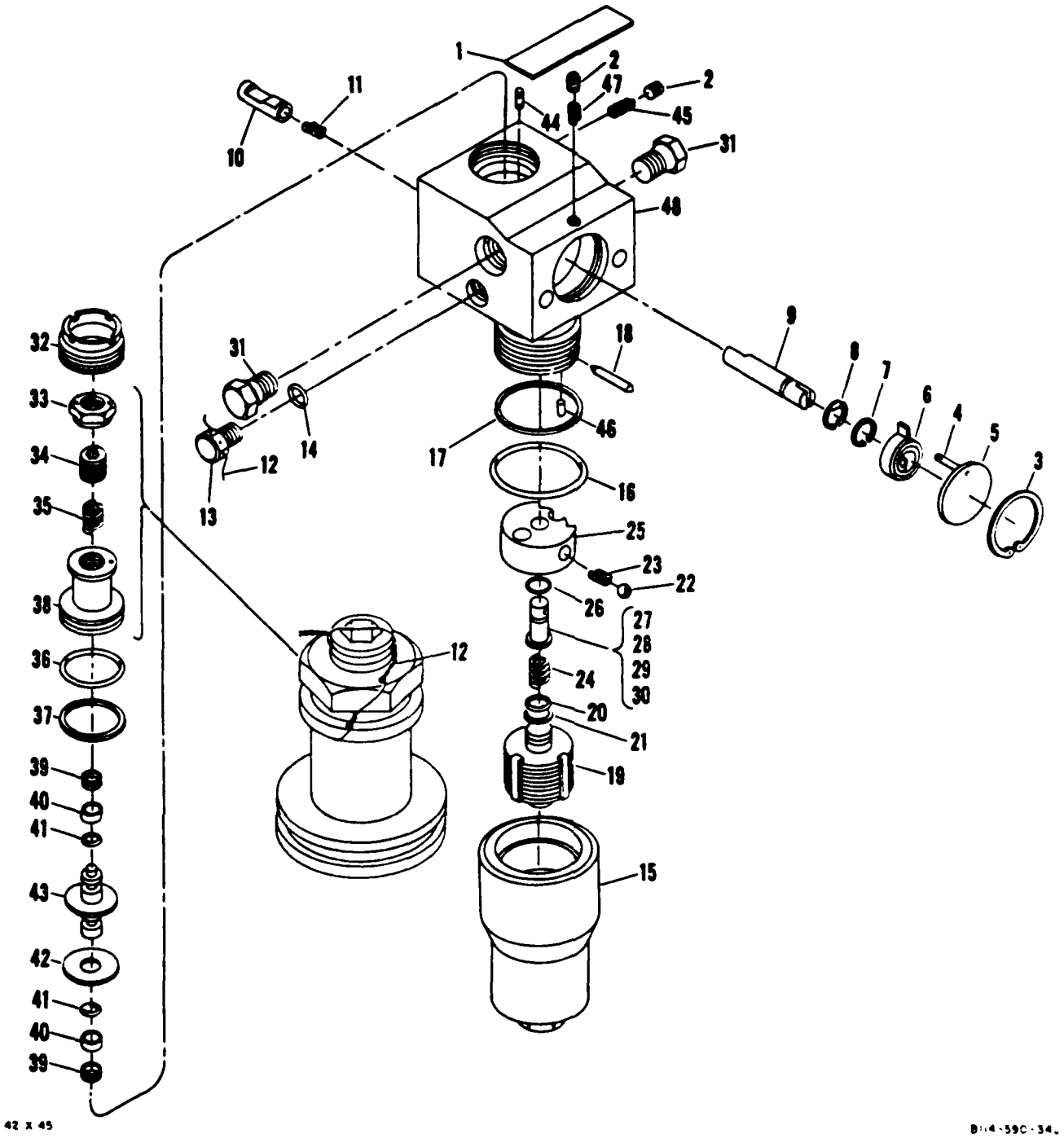
AD-A169 019 A PROTOTYPE MAINTENANCE EXPERT SYSTEM FOR THE CH-47 2/2
FLIGHT CONTROL HYDRAU..(U) PRINCETON UNIV NJ DEPT OF
MECHANICAL AND AEROSPACE ENGINEERIN.. C J LOH
UNCLASSIFIED 28 APR 86 MAE-1751 ARO-20155.8-MA F/G 14/2 NL




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.8
3.2
3.6
4.0

CORRECTIVE ACTIONS: FAULTY PRESSURE FILTERS 114HS120-13 AND -14
REMOVE PLUG AND REPLACE PACKING #14

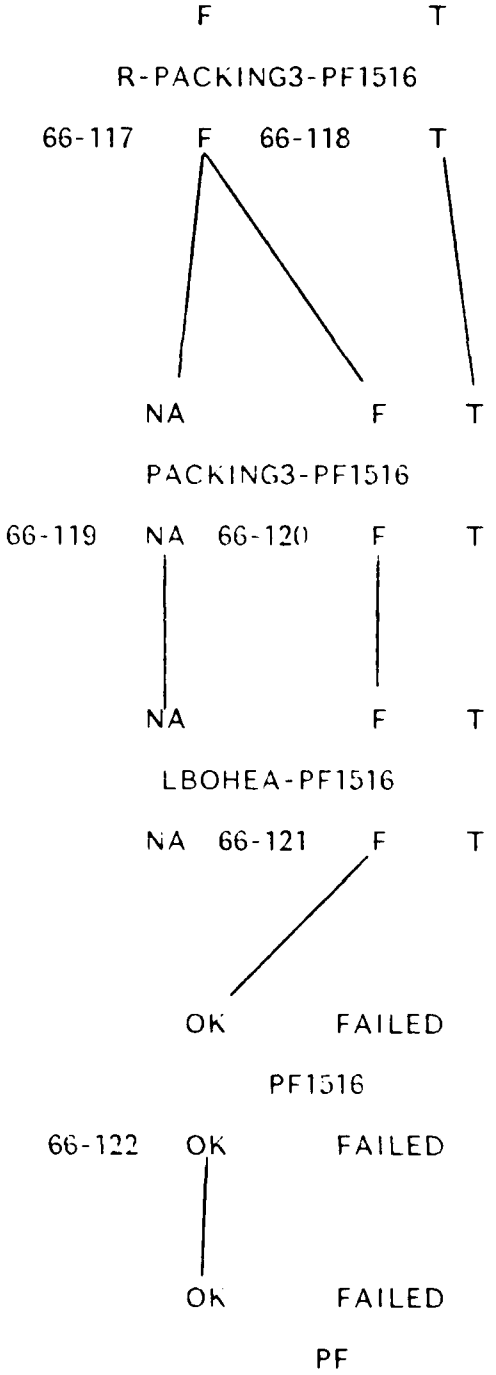




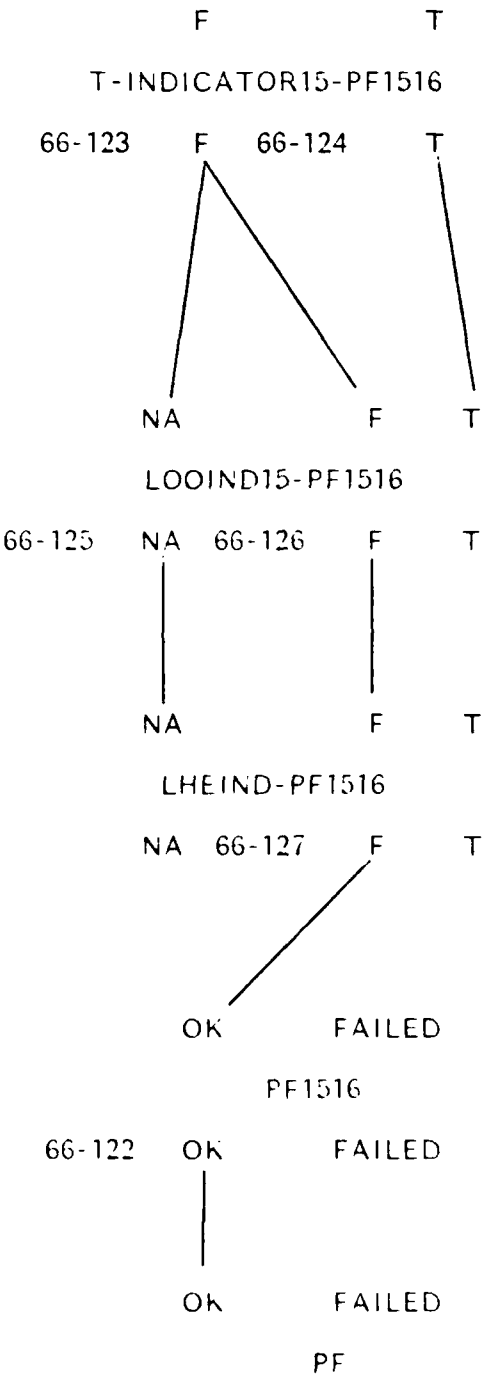
1. Nameplate	13. Bleed plug	25. Shutoff valve	37. Retainer
2. Screw	14. Packing	26. Shim	38. Guide end
3. Retaining ring	15. Bowl	27. Stud bushing	39. Retainer
4. Pin	16. Packing	28. Plate	40. Sleeve
5. Cover	17. Ring	29. Spring	41. Packing
6. Lockout thermospiral	18. Pin	30. Housing	42. Diaphragm
7. Ring	19. Element	31. Plug	43. Spool
8. Ring	20. Packing	32. Ring nut	44. Plug
9. Shaft	21. Ring	33. Locknut	45. Insert
10. Indicator	22. Ball	34. Adjusting plug	46. Pin
11. Spring	23. Spring	35. Spring	47. Insert
12. Lockwire	24. Spring	36. Packing	48. Head

PRESSURE FILTERS 114HS120-13 AND -14
FIGURE 13

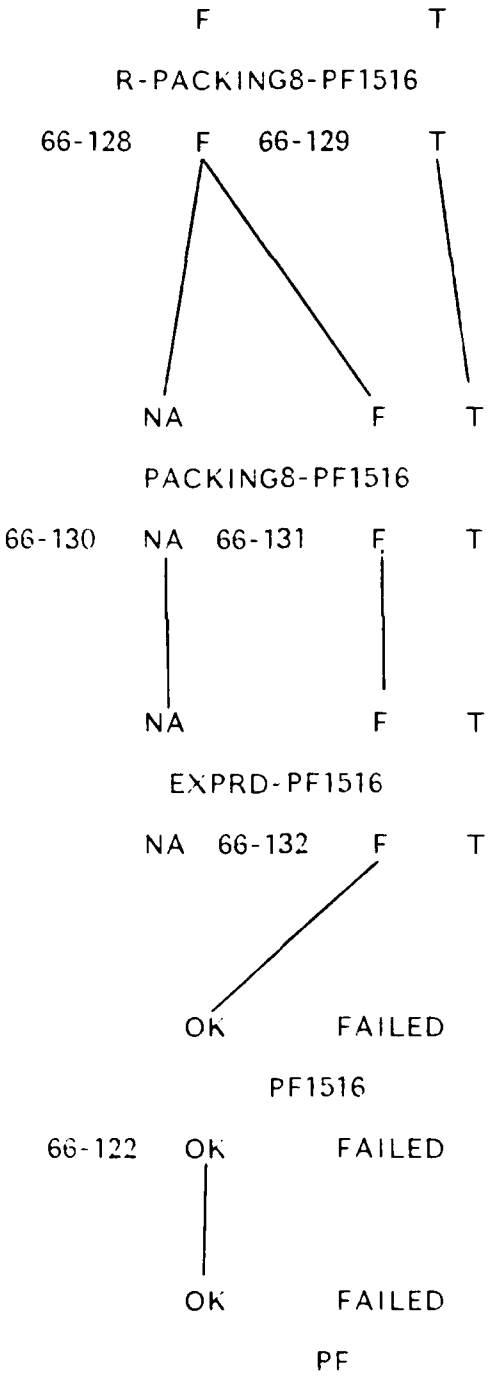
CORRECTIVE ACTIONS: FAULTY PRESSURE FILTERS 114HS120-15 AND -16 REPLACE PACKING #3



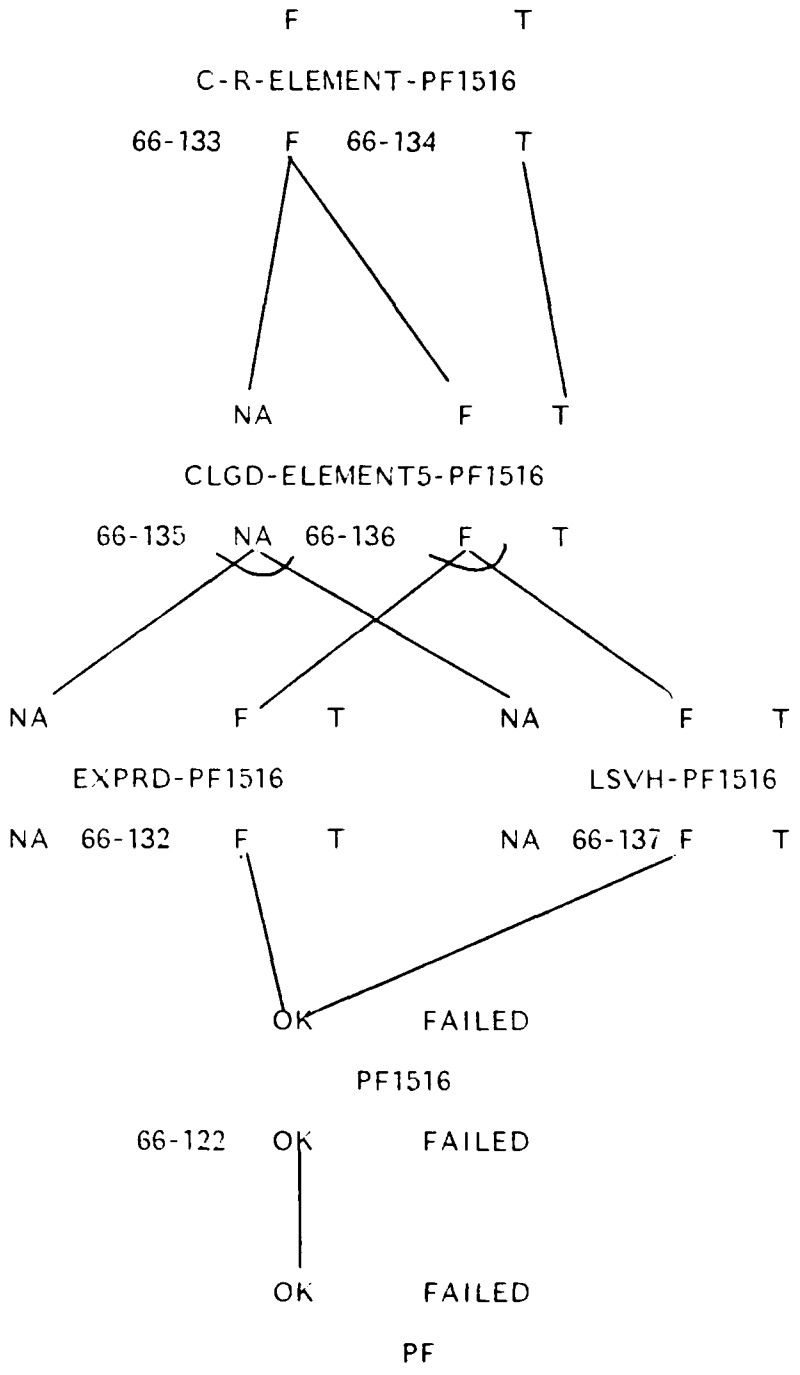
CORRECTIVE ACTIONS: FAULTY PRESSURE FILTERS 114HS120-15 AND -16 TIGHTEN INDICATOR



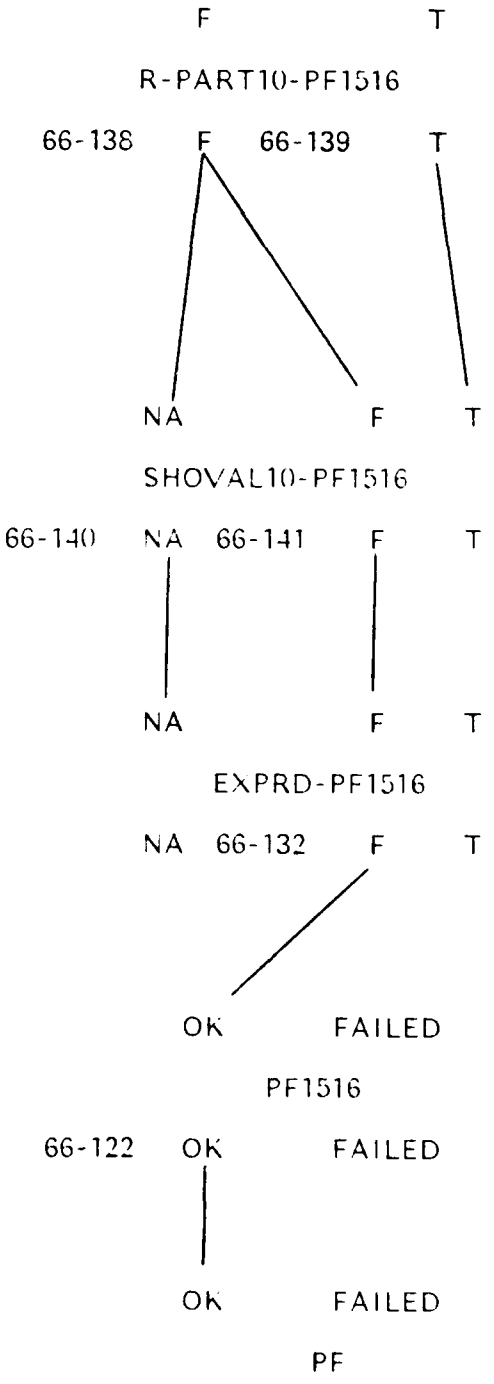
CORRECTIVE ACTIONS: FAULTY PRESSURE FILTERS 114HS120-15 AND -16 REPLACE PACKING #8



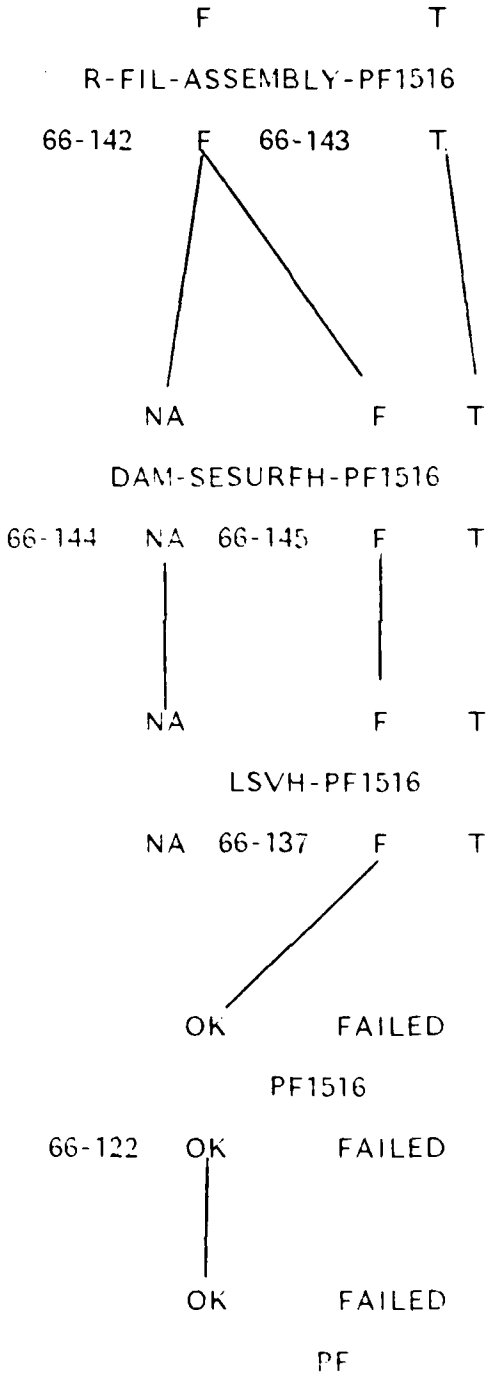
CORRECTIVE ACTIONS: FAULTY PRESSURE FILTERS 114HS120-15 AND -16 CLEAN OR REPLACE ELEMENT



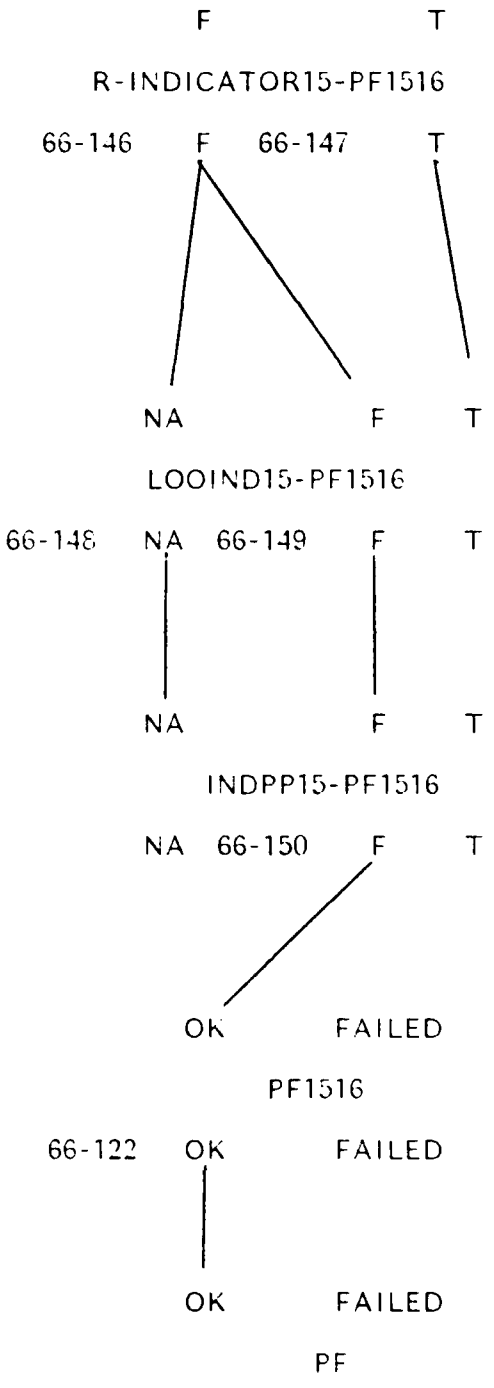
CORRECTIVE ACTIONS: FAULTY PRESSURE FILTERS 114HS120-15 AND -16 REPLACE DEFECTIVE PART OF SHUTOFF VALVE

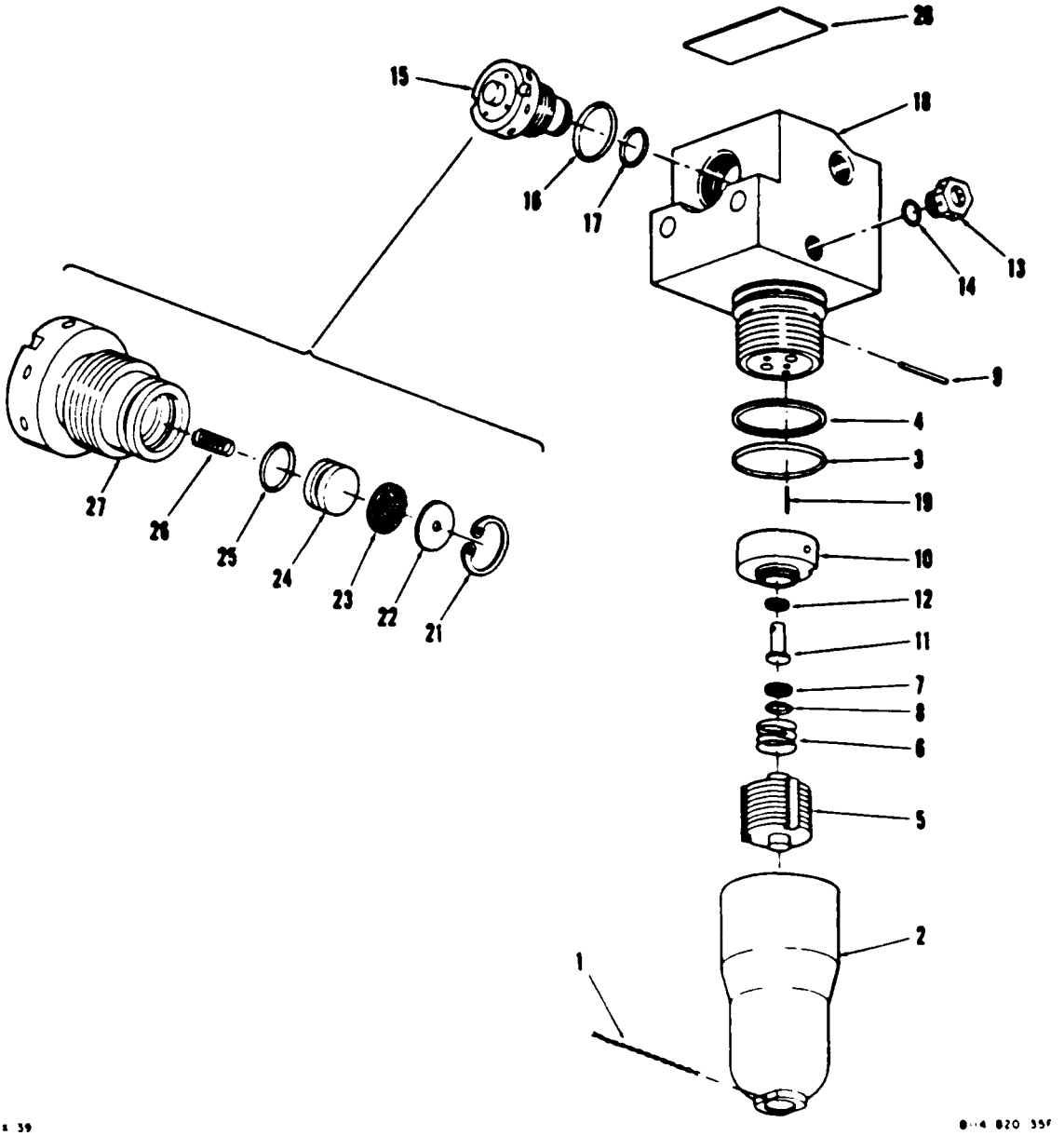


CORRECTIVE ACTIONS: FAULTY PRESSURE FILTERS 114HS120-15 AND -16
REPLACE FILTER ASSEMBLY



CORRECTIVE ACTIONS: FAULTY PRESSURE FILTERS 114HS120-15 AND -16 REPLACE INDICATOR #15

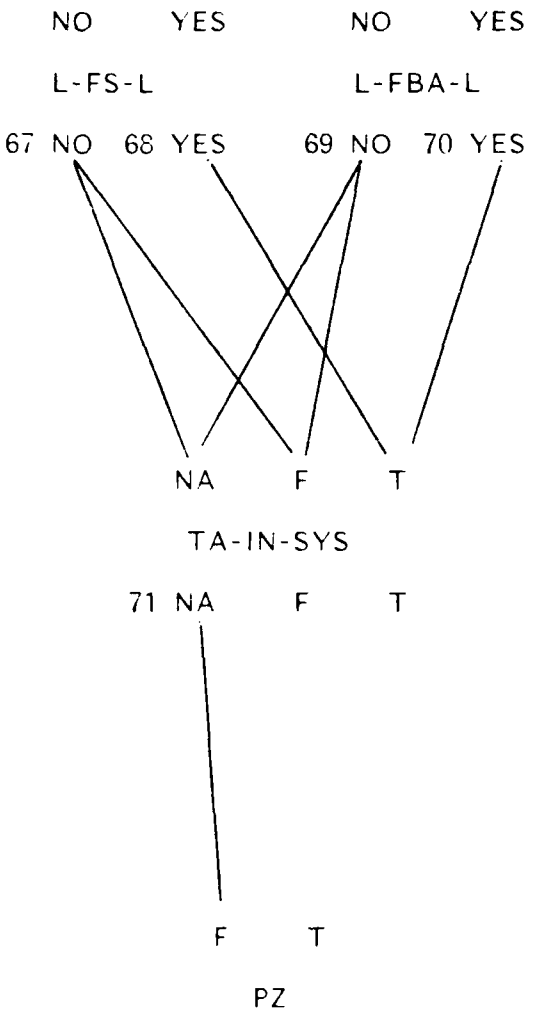




1	Lockwire	15	Indicator assembly
2	Bowl	16	Packing
3	Packing	17	Packing
4	Ring	18	Head
5	Element	19	Splitpin
6	Spring	20	Nameplate
7	Ring	21	Retainer
8	Packing	22	Plate
9	Pin	23	Filter
10	Valve	24	Piston
11	Bushing	25	Packing
12	Shim	26	Spring
13	Plug	27	Housing
14	Packing		

PRESSURE FILTERS 114HS120-15 AND -16
FIGURE 14

LOOSEN LINES



Appendix E

KNOWLEDGE BASE SOURCE CODE

The following knowledge base is coded in IQLISP. As of April 25, 1986, there are 155 parameters and 258 rules. It is listed in subdirectory CLOH and under filename LOHKB.LSP.

```
~LOADING THE EXPERT SYSTEM SHELL

(FLOAD "EXPSHELL")



(MSG 'CR "Reading Knowledge Base")



~ #####   KNOWLEDGE BASE PARAMETER GROUPS   ############################

~                                   Christopher J. Loh
~                                   Laboratory for Control & Automation
~                                   Knowledge Base
~                                   CH-47 Flight Control Hydraulic System
~                                   Fall / Spring 1985-1986


~ PARAMETER GROUP PROPERTIES
~   system-supplied:
~     used-by          specifies rules with this parameter in their premise
~     contained-in     specifies rules with this parameter in their action
~                      but that do not assign a value to the parameter
~     updated-by       specifies rules that conclude a value for this parameter
~                      in their action
~   user-supplied:
~     trans            English translation (definition)
~     expect
~     initial-value
~     never-ask        If a parameter value is unknown, it cannot be inferred
~                      with rules, and has never-ask TRUE, then the search fails
~     prompt
~     askfirst
~     justification

~  FCHS = flight control hydraulic system


(INTERN-SYMBOL-GROUP    *PARAMETER-GROUP*


~ Top Level Goal

  (FAILURE-DETECTED
    (TRANS '(The failure-s has been detected in the FCHS))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK T))

  (ALL-DEVICES-TESTED
    (TRANS '(All devices in FCHS have been tested for possible malfunctions))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK T))

  (NOTHING-FAILED
```

```
    (TRANS '(All devices in FCHS have been found to be operational))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK T))

~ Possible Device Failures / Corrective Actions

  (EC-FCP
    (TRANS '(Electric circuit to hydraulic flight control pump in FCHS status))
    (EXPECT '(OK FAILED))
    (NEVER-ASK NIL))

  (SH-BO2
    (TRANS '(Set hydraulic boost 2 on in FCHS))
    (EXPECT '(YES NO))
    (NEVER-ASK NIL))

  (FCM
    (TRANS '(Flight control manifold status in FCHS))
    (EXPECT '(OK FAILED))
    (NEVER-ASK NIL))

  (TA-AT-PT
    (TRANS '(Trapped air at pressure transmitter in FCHS status))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

  (PI
    (TRANS '(Pressure indicator status in FCHS))
    (EXPECT '(OK FAILED))
    (NEVER-ASK NIL))

  (PT1
    (TRANS '(Pressure transmitter status in FCHS determined by pressure
             indication value))
    (EXPECT '(OK FAILED))
    (NEVER-ASK NIL))

  (PT2
    (TRANS '(Pressure transmitter status in FCHS determined by
             accumulator gage pressure indication between
             2500 and 3200 psi))
    (EXPECT '(OK FAILED))
    (NEVER-ASK NIL))

  (PT3
    (TRANS '(Pressure transmitter status in FCHS determined by
             accumulator gage fluctuation))
    (EXPECT '(OK FAILED))
    (NEVER-ASK NIL))

  (FCP1
    (TRANS '(Flight control pump status in FCHS determined by accumulator
             gage pressure))
    (EXPECT '(OK FAILED))
    (NEVER-ASK NIL))

  (FCP2
```

```
    (TRANS '(Flight control pump status in FCHS determined by
             temperature at hose fitting))
    (EXPECT '(OK FAILED))
    (NEVER-ASK NIL))

  (FCP3
    (TRANS '(Flight control pump status in FCHS determined by
             temperature differential at inlet and outlet port))
    (EXPECT '(OK FAILED))
    (NEVER-ASK NIL))

  (FCM
    (TRANS '(Flight control manifold status in FCHS))
    (EXPECT '(OK FAILED))
    (NEVER-ASK NIL))

  (PRV
    (TRANS '(Pressure reduce valve status in FCHS))
    (EXPECT '(OK FAILED))
    (NEVER-ASK NIL))

  (FBA
    (TRANS '(Flight boost accumulator status in FCHS))
    (EXPECT '(OK FAILED))
    (NEVER-ASK NIL))

  (HT
    (TRANS '(Hydraulic tank status in FCHS))
    (EXPECT '(OK FAILED))
    (NEVER-ASK NIL))

  (PF
    (TRANS '(Pressure filter status in FCHS))
    (EXPECT '(OK FAILED))
    (NEVER-ASK NIL))

  (RF
    (TRANS '(Return filter status in FCHS))
    (EXPECT '(OK FAILED))
    (NEVER-ASK NIL))

  (L-FS-L
    (TRANS '(Loosen flexible supply line to flight control pump in FCHS))
    (EXPECT '(YES NO))
    (NEVER-ASK NIL))

  (L-FBA-L
    (TRANS '(Loosen line to flight boost accumulator in FCHS))
    (EXPECT '(YES NO))
    (NEVER-ASK NIL))


~ Symptoms Which Lead to Device Failures

  (PI-L
    (TRANS '(Pressure indicator is low in FCHS))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))
```

```
(PI-F
  (TRANS '(Pressure indicator is fluctuating in FCHS))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(AGP-2500-3200
  (TRANS '(Accumulator gage pressure between 2500 and 3200
           with FCHS depressurized))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(HBF-1CL-ON
  (TRANS '(HYD BOOST OFF FCHS 1 caution light on))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(TDA-PRV
  (TRANS '(Temperature differential between inlet and outlet
           of pressure reduce valve in FCHS is abnormal))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(TDA-FBA
  (TRANS '(Temperature differential between inlet and outlet
           of flight boost accumulator in FCHS is abnormal))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(TDA-FCP
  (TRANS '(Temperature differential between inlet and outlet
           of flight control pump in FCHS is abnormal))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(TDA-HT
  (TRANS '(Temperature differential between inlet and outlet
           of hydraulic tank in FCHS is abnormal))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(TDA-PF
  (TRANS '(Temperature differential between inlet and outlet
           of pressure filter in FCHS is abnormal))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(TDA-RF
  (TRANS '(Temperature differential between inlet and outlet
           of return filter in FCHS is abnormal))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(AGP-EQ-P
  (TRANS '(Accumulator gage pressure in FCHS is equal to cockpit
           pressure indication))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))
```

```
(AGB-28
  (TRANS '(Temperature of hose fitting at pump pressure port in FCHS
           is greater than temperature of hose fitting at pump
           case drain port by 28 degrees celsius))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(BG-102
  (TRANS '(Temperature of hose fitting at pump case drain port in FCHS
           is greater than 102 degrees celsius))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(TC-GTE-TA
  (TRANS '(Temperature of return line tube assembly at flight control
           manifold in FCHS is greater than or equal to temperature
           of hose fitting at pump pressure port))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(NP-2500-3200
  (TRANS '(Pressure in FCHS is between 2500 and 3200 psi
           after electric circuit is disconnected))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(NP-EQ-P
  (TRANS '(Pressure in FCHS remains essentially unchanged
           after electric circuit is disconnected))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(IPS
  (TRANS '(Inoperative pneumatic system))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(P-450-550
  (TRANS '(Pressure in FCHS is between 450 and 550 psi after apu start))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(AG-F
  (TRANS '(Accumulator gage fluctuation in FCHS))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(TA-IN-SYS
  (TRANS '(Trapped air in FCHS))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(PL
  (TRANS '(Initial pressure check in FCHS is low - less than 2500 psi))
  (EXPECT '(TRUE FALSE))
  (NEVER-ASK NIL))
```

```
(PH
  (TRANS '(Initial pressure check in FCHS is high - greater than 3200 psi))
  (EXPECT '(TRUE FALSE))
  (NEVER-ASK NIL))

(PZ
  (TRANS '(Initial pressure check in FCHS is zero))
  (EXPECT '(TRUE FALSE))
  (NEVER-ASK NIL))

(PFL
  (TRANS '(Initial pressure check in FCHS is fluctuating))
  (EXPECT '(TRUE FALSE))
  (NEVER-ASK NIL))


~ FOCUS PARAMETERS FOR FLIGHT CONTROL PUMP


(SSL4-FCP
  (TRANS '(Shaft seal leaks #4 in flight control pump))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(CFEPS-FCP
  (TRANS '(Carbon-faced encased plain seal damaged in flight control
           pump))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(R-SEAL4-FCP
  (TRANS '(Replace the seals #4 in flight control pump))
  (EXPECT '(TRUE FALSE))
  (NEVER-ASK NIL))

(EL-FCP
  (TRANS '(External leakage in flight control pump))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))


(LAP-FCP
  (TRANS '(Loose attaching parts in flight control pump))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(T-BOLTS-FCP
  (TRANS '(Tighten bolts or screws in leaking areas in flight
           control pump))
  (EXPECT '(TRUE FALSE))
  (NEVER-ASK NIL))

(PACKING-FCP
  (TRANS '(Damaged or twisted packings in flight control pump))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(R-PACKING-FCP
```

```
    (TRANS '(Replace the packings in flight control pump))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

  (SNMATSUR-FCP
    (TRANS '(Scoring or nicks on mating surfaces in flight control
             pump))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (R-PUMP1-FCP
    (TRANS '(Replace the pumps due to scoring or nicks at mating
            surfaces in flight control pump))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

  (R-PUMP2-FCP
    (TRANS '(Replace the pumps due to sticking compensator spring #11
             and #12 in flight control pump))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

  (R-PUMP3-FCP
    (TRANS '(Replace the pumps due to loose or sticking spool valve #13
             in flight control pump))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

  (R-PUMP4-FCP
    (TRANS '(Replace the pumps due to broken compensator spring #11
             and #12 in flight control pump))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

  (R-PUMP5-FCP
    (TRANS '(Replace the pumps due to faulty compensator action #14
            in flight control pump))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

  (HFC-FCP
    (TRANS '(Excessive hunting, fluctuation or cavitation
            in flight control pump))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (SCOMPSPR1112-FCP
    (TRANS '(Sticking compensator spring #11 and #12 in flight control
             pump))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (LSSPOOLV13-FCP
    (TRANS '(Loose or sticking spool valve #13 in flight control
            pump))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))
```

```
(LP-FCP
  (TRANS '(Low pressure in flight control pump))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(BCOMPSPR1112-FCP
  (TRANS '(Broken compensator spring #11 and #12 in flight control
         pump))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(HP-FCP
  (TRANS '(High pressure in flight control pump))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(FCOMPENSATOR14-FCP
  (TRANS '(Faulty compensator action #14 in flight control pump))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))


~ FOCUS PARAMETERS FOR PRESSURE FILTER 13, 14

(PF1314
  (TRANS '(Pressure filter -13 and -14 are damaged))
  (EXPECT '(OK FAILED))
  (NEVER-ASK NIL))

(LBOHEA-PF1314
  (TRANS '(Leak between bowl and head assembly in pressure filter
          13, 14))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(PACKING7-PF1314
  (TRANS '(Damaged packings #7 in pressure filter 13, 14))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(R-BOWL-PACKING-PF1314
  (TRANS '(Remove bowl and replace packing in pressure filter 13, 14))
  (EXPECT '(TRUE FALSE))
  (NEVER-ASK NIL))

(LPDIFFIND-PF1314
  (TRANS '(Leak around pressure differential indicator in pressure
          filter 13, 14))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(DAMSLSL40-PF1314
  (TRANS '(Damaged sliding sleeve #40 in pressure filter 13, 14))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(R-SPOOL43-PF1314
  (TRANS '(Replace spool assembly #43 in pressure filter 13, 14))
```

```
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

  (LADPLUG-PF1314
    (TRANS '(Leak at adjusting plug in pressure filter 13, 14))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (PDIFFINDE-PF1314
    (TRANS '(Pressure differential indicator extended; filter
             element clean in pressure filter 13, 14))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (INADPDIFF-PF1314
    (TRANS '(Incorrectly adjusted pressure differential drop in
            pressure filter 13, 14))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (C-ADJUSTMENT-PF1314
    (TRANS '(Correct adjustment in pressure filter 13, 14))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

  (LBLEPL-PF1314
    (TRANS '(Leak at bleed plug in pressure filter 13, 14))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (PACKING14-PF1314
    (TRANS '(Damaged packing #14 in pressure filter 13, 14))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (R-PLUG-PACKING14-PF1314
    (TRANS '(Remove plug and replace packing in pressure filter 13, 14))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

~ FOCUS PARAMETERS FOR PRESSURE FILTER 15, 16

  (PF1516
    (TRANS '(Pressure filter -15 and -16 are damaged))
    (EXPECT '(OK FAILED))
    (NEVER-ASK NIL))

  (LBOHEA-PF1516
    (TRANS '(Leakage between bowl and head in pressure filter 15, 16))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (PACKING3-PF1516
    (TRANS '(Faulty packing #3 in pressure filter 15, 16))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (R-PACKING3-PF1516
```

```
    (TRANS '(Replace packing #3 in pressure filter 15, 16))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

  (LHEIND-PF1516
    (TRANS '(Leakage between head and indicator in pressure filter
             15, 16))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (LOOIND15-PF1516
    (TRANS '(Loose indicator #15 in pressure filter 15, 16))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (T-INDICATOR15-PF1516
    (TRANS '(Tighten indicator #15 in pressure filter 15, 16))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

  (EXPRD-PF1516
    (TRANS '(Low output, excessive pressure drop in pressure filter
             15, 16))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (PACKING8-PF1516
    (TRANS '(Damaged packing #8 in pressure filter 15, 16))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (R-PACKING8-PF1516
    (TRANS '(Replace packing #8 in pressure filter 15, 16))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

  (CLGD-ELEMENT5-PF1516
    (TRANS '(Clogged or dirty element #5 in pressure filter 15, 16))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (C-R-ELEMENT-PF1516
    (TRANS '(Clean or replace element in pressure filter 15, 16))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

  (SHOVAL10-PF1516
    (TRANS '(Shutoff valve #10 not properly opened in pressure
             filter 15, 16))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (R-PART10-PF1516
    (TRANS '(Replace defective part of shutoff valve in pressure
            filter 15, 16))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))
```

```
(LSVH-PF1516
  (TRANS '(Excessive leakage between shutoff valve and head
           in pressure filter 15, 16))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(DAM-SESURFH-PF1516
  (TRANS '(Damaged sealing surface on head in pressure filter 15, 16))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(R-FIL-ASSEMBLY-PF1516
  (TRANS '(Replace filter assembly in pressure filter 15, 16))
  (EXPECT '(TRUE FALSE))
  (NEVER-ASK NIL))

(INDPP15-PF1516
  (TRANS '(Indicator #15 does not actuate at preset pressure
           filter 15, 16))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(R-INDICATOR15-PF1516
  (TRANS '(Replace indicator #15 in pressure filter 15, 16))
  (EXPECT '(TRUE FALSE))
  (NEVER-ASK NIL))


~ FOCUS PARAMETERS FOR PRESSURE REDUCING VALVES 26C266-02, 03, 08

(PRV238
  (TRANS '(Pressure reducing valve -02, -03, -08 are damaged))
  (EXPECT '(OK FAILED))
  (NEVER-ASK NIL))

(CYCLE-SYSTEM-PRV238
  (TRANS '(Cycle the affected system long enough to moisten the
           seals in pressure reducing valve 2,3,8))
  (EXPECT '(TRUE FALSE))
  (NEVER-ASK NIL))

(E-L-PRV238
  (TRANS '(External leakage in pressure reducing valve 2,3,8))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(S-L-PRV238
  (TRANS '(Static leakage in pressure reducing valve 2,3,8))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(PACKING2-PRV238
  (TRANS '(Damaged or incorrectly installed packing #2 in pressure
           reducing valve 2,3,8))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(R-PACKING2-PRV238
```

```
    (TRANS '(Replace packing #2 in pressure reducing valve 2,3,8))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

  (RET-PORT-PRV238
    (TRANS '(Relief flow from return port is not within specified
             limits in pressure reducing valve 2,3,8))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (IADJ-REL-VAL8-PRV238
    (TRANS '(Incorrectly adjusted relief valve #8 in pressure reducing
             valve 2,3,8))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (A-REL-VAL8-PRV238
    (TRANS '(Adjust relief valve #8 in pressure reducing valve 2,3,8))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

  (F-REL-VAL8-PRV238
    (TRANS '(Faulty relief valve #8 in pressure reducing valve 2,3,8))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (R-REL-VAL8-PRV238
    (TRANS '(Replace relief valve #8 assembly asd a matched set in
             pressure reducing valve 2,3,8))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

  (LEAKAGE-RESEAT-PRV238
    (TRANS '(Leakage at reseat exceeds specified limits in pressure
             reducing valve 2,3,8))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (SPRING13-PRV238
    (TRANS '(Faulty spring #13 in pressure reducing valve 2,3,8))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (R-SPRING13-PRV238
    (TRANS '(Replace spring #13 in pressure reducing valve 2,3,8))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

  (REG-PORT-PRV238
    (TRANS '(Flow from reg port not within specified limits in pressure
             reducing valve 2,3,8))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (REDUCER-VAL12-PRV238
    (TRANS '(Incorrectly adjusted reducer valve #12 in pressure reducing
             valve 2,3,8))
    (EXPECT '(TRUE FALSE NA))
```

```
    (NEVER-ASK NIL))

  (A-RED-VAL12-PRV238
    (TRANS '(Adjust reducer valve #12 in pressure reducing valve 2,3,8))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

  (POPPET21-SLEEVE22-PRV238
    (TRANS '(Faulty poppet #21 and sleeve assembly #22 in pressure
             reducing valve 2,3,8))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (R-POPPET21-SLEEVE22-PRV238
    (TRANS '(Replace poppet #21 and sleeve assembly #22 as a matched
             set in pressure reducing valve 2,3,8))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

  (L-RET-PORT-PRV238
    (TRANS '(Leakage from ret port exceeds specified limit in pressure
             reducing valve 2,3,8))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (PACKING1923-PRV238
    (TRANS '(Damaged or incorrectly installed packings #19 and #23 in
             pressure reducing valve 2,3,8))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (R-PACKING1923-PRV238
    (TRANS '(Replace packing #19 and #23 in pressure reducing valve
             2,3,8))
    (EXPECT '(TRUE FALSE))
    (NEVER-ASK NIL))

~ FOCUS PARAMETERS FOR PRESSURE REDUCING VALVES 3A-011

  (PRV3A
    (TRANS '(Pressure reducing valves -011 is damaged))
    (EXPECT '(OK FAILED))
    (NEVER-ASK NIL))

  (E-L-PRV3A
    (TRANS '(External leakage in pressure reducing valves -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (PACKING410-PRV3A
    (TRANS '(Damaged packing #4 or #10 in pressure reducing valve
             -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (R-PACKING410-PRV3A
    (TRANS '(Replace packing #4 or #10 in pressure reducing valve -011))
    (EXPECT '(TRUE FALSE NA))
```

```
    (NEVER-ASK NIL))

  (RING39-PRV3A
    (TRANS '(Incorrectly assembled backup rings #3 or #9 in pressure
             reducing valve -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (R-RING39-PRV3A
    (TRANS '(Remove and reassemble backup ring #3 or #9 in pressure
             reducing valve -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (EX-L-RETPORT-PRV3A
    (TRANS '(Excessive internal leakage through return port in pressure
             reducing valve -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (PACKING2123-PRV3A
    (TRANS '(Damaged packing #21 or #23 in pressure reducing valve
             -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (R-PACKING2123-PRV3A
    (TRANS '(Replace packing #21 or #23 in pressure reducing valve
             -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (RING20-PRV3A
    (TRANS '(Incorrectly  assembled backup ring #20 in pressure
             reducing valve -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (R-RING20-PRV3A
    (TRANS '(Remove and reassemble backup ring #20 in pressure
             reducing valve -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (EX-FLOW-RETPORT-PRV3A
    (TRANS '(Excessive flow thru return port during leakage test in
            pressure reducing valve -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (PLUNGER14-BARREL15-PRV3A
    (TRANS '(Integral relief valve cracks due to pressure build-up
             caused by leakage thru seat on barrel #15
             in pressure reducing valve -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (R-PLUNGER14-BARREL15-PRV3A
```

```
    (TRANS '(Replace plunger #14 and barrel #15 in pressure reducing
             valve -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (DASHPOT16-PRV3A
    (TRANS '(Incorrectly assembled dashpot #16 in pressure reducing
             valve -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (R-DASHPOT16-PRV3A
    (TRANS '(Remove and reassemble dashpot #16 in pressure reducing
             valve -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (REL-VAL-LOW-PRV3A
    (TRANS '(Integral relief valve cracks low at correct pressure
             setting in pressure reducing valve -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (BALL-SEAT19-PRV3A
    (TRANS '(Damaged ball seat #19 in pressure reducing valve -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (R-BALL-SEAT19-PRV3A
    (TRANS '(Reseat or replace ball seat #19 in pressure reducing
            valve -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (REL-VAL-HIGH-PRV3A
    (TRANS '(Integral relief valve cracks high and reseats low in
             pressure reducing valve -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (PUSHROD17-BARREL15-PRV3A
    (TRANS '(Binding between pushrod #17 and barrel #15 is faulty
             in pressure reducing valve -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (BUFF-CLEAN1-PRV3A
    (TRANS '(Buff and clean pushrod #17 and barrel #15 and check for
            smooth fit in pressure reducing valve -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))

  (BUFF-CLEAN2-PRV3A
    (TRANS '(Buff and clean binding between various components in
             pressure reducing valve -011))
    (EXPECT '(TRUE FALSE NA))
    (NEVER-ASK NIL))
```

```
(VAL-RED-PRV3A
  (TRANS '(Valve fails to reduce correctly in pressure reducing
           valve -011))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(BINDING-PRV3A
  (TRANS '(Binding between various components is faulty in pressure
           reducing valve -011))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(WRONG-PACKING-PRV3A
  (TRANS '(Incorrect assembly or wrong size packing in pressure
           reducing valve -011))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(R-PACKING-PRV3A
  (TRANS '(Remove and reassemble packing in pressure reducing valve
           -011))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(VAL-SQUEALS-PRV3A
  (TRANS '(Valve chatters or squeals in pressure reducing valve -011))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(C-PLUNGER14-PRV3A
  (TRANS '(Check for free fit with plunger #14  and reassemble in
           pressure reducing valve -011))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(PACKING12-WASHER11-PRV3A
  (TRANS '(Incorrect assembly of packing #12 and washer #11 in
           pressure reducing valve -011))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(R-PACKING12-WASHER11-PRV3A
  (TRANS '(Remove and reassemble packing #12 and washer #11 in
           pressure reducing valve -011))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(FITTING8-PRV3A
  (TRANS '(Tight fitting #8 in pressure reducing valve -011))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL))

(R-FITTING8-PRV3A
  (TRANS '(Unscrew and retorque fitting #8 to 250 pound-inches in
           pressure reducing valve -011))
  (EXPECT '(TRUE FALSE NA))
  (NEVER-ASK NIL)))
```

```
~ #####   KNOWLEDGE BASE RULE GROUPS   ###################################


~ RULE GROUP PROPERTIES
~   trans
~   premise
~   action



(INTERN-SYMBOL-GROUP   *RULE-GROUP*

  (RULE001
    (TRANS
      '(if   all devices tested is true and nothing failed is also true
        then failure detected is false))
    (PREMISE
      '(AND ($EQ ALL-DEVICES-TESTED 'TRUE) ($EQ NOTHING-FAILED 'TRUE)))
    (ACTION
      '($SETQ FAILURE-DETECTED 'FALSE)))

  (RULE002
    (TRANS
      '(if   all devices tested is true and nothing failed is false
        then failure detected is true))
    (PREMISE
      '(AND ($EQ ALL-DEVICES-TESTED 'TRUE) ($EQ NOTHING-FAILED 'FALSE)))
    (ACTION
      '($SETQ FAILURE-DETECTED 'TRUE)))

  (RULE003
    (TRANS
      '(if    all devices are not unknown
        then  all devices tested is true))
    (PREMISE
      '(AND (NOT ($EQ EC-FCP 'FOO))
            (NOT ($EQ SH-BO2 'FOO))
            (NOT ($EQ FCM 'FOO))
            (NOT ($EQ TA-AT-PT 'FOO))
            (NOT ($EQ PI 'FOO))
            (NOT ($EQ PT1 'FOO))
            (NOT ($EQ PT2 'FOO))
            (NOT ($EQ PT3 'FOO))
            (NOT ($EQ FCP1 'FOO))
            (NOT ($EQ FCP2 'FOO))
            (NOT ($EQ FCP3 'FOO))
            (NOT ($EQ R-SEAL4-FCP 'FOO))
            (NOT ($EQ T-BOLTS-FCP 'FOO))
            (NOT ($EQ R-PACKING-FCP 'FOO))
            (NOT ($EQ R-PUMP1-FCP 'FOO))
            (NOT ($EQ R-PUMP2-FCP 'FOO))
            (NOT ($EQ R-PUMP3-FCP 'FOO))
            (NOT ($EQ R-PUMP4-FCP 'FOO))
            (NOT ($EQ R-PUMP5-FCP 'FOO))
```

```
            (NOT ($EQ PRV 'FOO))
            (NOT ($EQ FBA 'FOO))
            (NOT ($EQ HT 'FOO))
            (NOT ($EQ PF 'FOO))
            (NOT ($EQ RF 'FOO))
            (NOT ($EQ CYCLE-SYSTEM-PRV238 'FOO))
            (NOT ($EQ R-PACKING2-PRV238 'FOO))
            (NOT ($EQ A-REL-VAL8-PRV238 'FOO))
            (NOT ($EQ R-REL-VAL8-PRV238 'FOO))
            (NOT ($EQ R-SPRING13-PRV238 'FOO))
            (NOT ($EQ A-RED-VAL12-PRV238 'FOO))
            (NOT ($EQ R-POPPET21-SLEEVE22-PRV238 'FOO))
            (NOT ($EQ R-PACKING1923-PRV238 'FOO))
            (NOT ($EQ R-PACKING410-PRV3A 'FOO))
            (NOT ($EQ R-RING39-PRV3A 'FOO))
            (NOT ($EQ R-PACKING2123-PRV3A 'FOO))
            (NOT ($EQ R-RING20-PRV3A 'FOO))
            (NOT ($EQ R-PLUNGER14-BARREL15-PRV3A 'FOO))
            (NOT ($EQ R-DASHPOT16-PRV3A 'FOO))
            (NOT ($EQ R-BALL-SEAT19-PRV3A 'FOO))
            (NOT ($EQ BUFF-CLEAN1-PRV3A 'FOO))
            (NOT ($EQ BUFF-CLEAN2-PRV3A 'FOO))
            (NOT ($EQ C-PLUNGER14-PRV3A 'FOO))
            (NOT ($EQ R-PACKING12-WASHER11-PRV3A 'FOO))
            (NOT ($EQ R-FITTING8-PRV3A 'FOO))
            (NOT ($EQ R-BOWL-PACKING-PF1314 'FOO))
            (NOT ($EQ R-SPOOL43-PF1314 'FOO))
            (NOT ($EQ C-ADJUSTMENT-PF1314 'FOO))
            (NOT ($EQ R-PLUG-PACKING14-PF1314 'FOO))
            (NOT ($EQ R-PACKING3-PF1516 'FOO))
            (NOT ($EQ T-INDICATOR15-PF1516 'FOO))
            (NOT ($EQ R-PACKING8-PF1516 'FOO))
            (NOT ($EQ C-R-ELEMENT-PF1516 'FOO))
            (NOT ($EQ R-PART10-PF1516 'FOO))
            (NOT ($EQ R-FIL-ASSEMBLY-PF1516 'FOO))
            (NOT ($EQ R-INDICATOR15-PF1516 'FOO))
            (NOT ($EQ L-FS-L 'FOO))
            (NOT ($EQ L-FBA-L 'FOO))))
    (ACTION
      '($SETQ ALL-DEVICES-TESTED 'TRUE)))

  (RULE004
    (TRANS
      '(if    any device failed or any corrective action taken
       then  nothing failed or no corrective action taken is false))
    (PREMISE
      '(OR ($EQ EC-FCP 'FAILED)
           ($EQ SH-BO2 'YES)
           ($EQ FCM 'FAILED)
           ($EQ TA-AT-PT 'TRUE)
           ($EQ PI 'FAILED)
           ($EQ PT1 'FAILED)
           ($EQ PT2 'FAILED)
           ($EQ PT3 'FAILED)
           ($EQ FCP1 'FAILED)
           ($EQ FCP2 'FAILED)
           ($EQ FCP3 'FAILED)
           ($EQ R-SEAL4-FCP 'TRUE)
```

```
            ($EQ T-BOLTS-FCP 'TRUE)
            ($EQ R-PACKING-FCP 'TRUE)
            ($EQ R-PUMP1-FCP 'TRUE)
            ($EQ R-PUMP2-FCP 'TRUE)
            ($EQ R-PUMP3-FCP 'TRUE)
            ($EQ R-PUMP4-FCP 'TRUE)
            ($EQ R-PUMP5-FCP 'TRUE)
            ($EQ PRV 'FAILED)
            ($EQ FBA 'FAILED)
            ($EQ HT 'FAILED)
            ($EQ PF 'FAILED)
            ($EQ RF 'FAILED)
            ($EQ CYCLE-SYSTEM-PRV238 'TRUE)
            ($EQ R-PACKING2-PRV238 'TRUE)
            ($EQ A-REL-VAL8-PRV238 'TRUE)
            ($EQ R-REL-VAL8-PRV238 'TRUE)
            ($EQ R-SPRING13-PRV238 'TRUE)
            ($EQ A-RED-VAL12-PRV238 'TRUE)
            ($EQ R-POPPET21-SLEEVE22-PRV238 'TRUE)
            ($EQ R-PACKING1923-PRV238 'TRUE)
            ($EQ R-PACKING410-PRV3A 'TRUE)
            ($EQ R-RING39-PRV3A 'TRUE)
            ($EQ R-PACKING2123-PRV3A 'TRUE)
            ($EQ R-RING20-PRV3A 'TRUE)
            ($EQ R-PLUNGER14-BARREL15-PRV3A 'TRUE)
            ($EQ R-DASHPOT16-PRV3A 'TRUE)
            ($EQ R-BALL-SEAT19-PRV3A 'TRUE)
            ($EQ BUFF-CLEAN1-PRV3A 'TRUE)
            ($EQ BUFF-CLEAN2-PRV3A 'TRUE)
            ($EQ C-PLUNGER14-PRV3A 'TRUE)
            ($EQ R-PACKING12-WASHER11-PRV3A 'TRUE)
            ($EQ R-FITTING8-PRV3A 'TRUE)
            ($EQ R-BOWL-PACKING-PF1314 'TRUE)
            ($EQ R-SPOOL43-PF1314 'TRUE)
            ($EQ C-ADJUSTMENT-PF1314 'TRUE)
            ($EQ R-PLUG-PACKING14-PF1314 'TRUE)
            ($EQ R-PACKING3-PF1516 'TRUE)
            ($EQ T-INDICATOR15-PF1516 'TRUE)
            ($EQ R-PACKING8-PF1516 'TRUE)
            ($EQ C-R-ELEMENT-PF1516 'TRUE)
            ($EQ R-PART10-PF1516 'TRUE)
            ($EQ R-FIL-ASSEMBLY-PF1516 'TRUE)
            ($EQ R-INDICATOR15-PF1516 'TRUE)
            ($EQ L-FS-L 'YES)
            ($EQ L-FBA-L 'YES)))
    (ACTION
      '($SETQ NOTHING-FAILED 'FALSE)))

  (RULE005
    (TRANS
      '(if    all devices are ok
       then  all nothing failed is true))
    (PREMISE
      '(AND ($EQ EC-FCP 'OK)
            ($EQ SH-BO2 'NO)
            ($EQ FCM 'OK)
            ($EQ TA-AT-PT 'FALSE)
            ($EQ PI 'OK)
```

```
            ($EQ PT1 'OK)
            ($EQ PT2 'OK)
            ($EQ PT3 'OK)
            ($EQ FCP1 'OK)
            ($EQ FCP2 'OK)
            ($EQ FCP3 'OK)
            ($EQ R-SEAL4-FCP 'FALSE)
            ($EQ T-BOLTS-FCP 'FALSE)
            ($EQ R-PACKING-FCP 'FALSE)
            ($EQ R-PUMP1-FCP 'FALSE)
            ($EQ R-PUMP2-FCP 'FALSE)
            ($EQ R-PUMP3-FCP 'FALSE)
            ($EQ R-PUMP4-FCP 'FALSE)
            ($EQ R-PUMP5-FCP 'FALSE)
            ($EQ PRV 'OK)
            ($EQ FBA 'OK)
            ($EQ HT 'OK)
            ($EQ PF 'OK)
            ($EQ RF 'OK)
            ($EQ CYCLE-SYSTEM-PRV238 'FALSE)
            ($EQ R-PACKING2-PRV238 'FALSE)
            ($EQ A-REL-VAL8-PRV238 'FALSE)
            ($EQ R-REL-VAL8-PRV238 'FALSE)
            ($EQ R-SPRING13-PRV238 'FALSE)
            ($EQ A-RED-VAL12-PRV238 'FALSE)
            ($EQ R-POPPET21-SLEEVE22-PRV238 'FALSE)
            ($EQ R-PACKING1923-PRV238 'FALSE)
            ($EQ R-PACKING410-PRV3A 'FALSE)
            ($EQ R-RING39-PRV3A 'FALSE)
            ($EQ R-PACKING2123-PRV3A 'FALSE)
            ($EQ R-RING20-PRV3A 'FALSE)
            ($EQ R-PLUNGER14-BARREL15-PRV3A 'FALSE)
            ($EQ R-DASHPOT16-PRV3A 'FALSE)
            ($EQ R-BALL-SEAT19-PRV3A 'FALSE)
            ($EQ BUFF-CLEAN1-PRV3A 'FALSE)
            ($EQ BUFF-CLEAN2-PRV3A 'FALSE)
            ($EQ C-PLUNGER14-PRV3A 'FALSE)
            ($EQ R-PACKING12-WASHER11-PRV3A 'FALSE)
            ($EQ R-FITTING8-PRV3A 'FALSE)
            ($EQ R-BOWL-PACKING-PF1314 'FALSE)
            ($EQ R-SPOOL43-PF1314 'FALSE)
            ($EQ C-ADJUSTMENT-PF1314 'FALSE)
            ($EQ R-PLUG-PACKING14-PF1314 'FALSE)
            ($EQ R-PACKING3-PF1516 'FALSE)
            ($EQ T-INDICATOR15-PF1516 'FALSE)
            ($EQ R-PACKING8-PF1516 'FALSE)
            ($EQ C-R-ELEMENT-PF1516 'FALSE)
            ($EQ R-PART10-PF1516 'FALSE)
            ($EQ R-FIL-ASSEMBLY-PF1516 'FALSE)
            ($EQ R-INDICATOR15-PF1516 'FALSE)
            ($EQ L-FS-L 'NO)
            ($EQ L-FBA-L 'NO)))
    (ACTION
      '($SETQ NOTHING-FAILED 'TRUE)))

  (RULE006
    (TRANS
      '(if   new pressure after electric circuit is disconnected is
```

```
            between 2500 and 3200 psi is not applicable or false
       then electric circuit to flight control pump is ok))
  (PREMISE
    '(OR ($EQ NP-2500-3200 'NA) ($EQ NP-2500-3200 'FALSE)))
  (ACTION
    '($SETQ EC-FCP 'OK)))

(RULE007
  (TRANS
    '(if   new pressure after electric circuit is disconnected is
           between 2500 and 3200 psi is true
       then electric circuit to flight control pump has failed))
  (PREMISE
    '($EQ NP-2500-3200 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "The ELECTRIC CIRCUIT to the flight control pump has been"
            'CR
            "determined to have failed due to pressure abnormality in pump"
            'CR
            "*****************************************************************"
            'CR)
       ($SETQ EC-FCP 'FAILED))))

(RULE008
  (TRANS
    '(if   pressure is between 450 and 550 psi after auxiliary power
           unit start is not applicable
       then new pressure after electric circuit is disconnected is
           between 2500 and 3200 psi is not applicable))
  (PREMISE
    '($EQ P-450-550 'NA))
  (ACTION
    '($SETQ NP-2500-3200 'NA)))

(RULE009
  (TRANS
    '(if   pressure is between 450 and 550 psi after auxiliary power
           unit start is false
       then new pressure after electric circuit is disconnected is
           between 2500 and 3200 psi is false))
  (PREMISE
    '($EQ P-450-550 'FALSE))
  (ACTION
    '($SETQ NP-2500-3200 'FALSE)))

(RULE010
  (TRANS
    '(if   pressure indication is low is false
       and pressure indication is high is false
       and pressure indication is zero is false
       and pressure indication is fluctuating is false
       then pressure is between 450 and 550 psi after auxiliary power
           unit start is not applicable))
  (PREMISE
```

```
      '(AND ($EQ PL 'FALSE) ($EQ PH 'FALSE)
            ($EQ PZ 'FALSE) ($EQ PFL 'FALSE)))
    (ACTION
      '($SETQ P-450-550 'NA)))

  (RULE010-1
    (TRANS
      '(if   initial pressure check is low is true
       then initial pressure check is high is false))
    (PREMISE
      '($EQ PL 'TRUE))
    (ACTION
      '($SETQ PH 'FALSE)))

  (RULE011
    (TRANS
      '(if   accumulator gage pressure with system depressurized is
             between 2500 and 3200 psi is not applicable or false
       then do not set hydraulic boost 2 switch on))
    (PREMISE
      '(OR ($EQ AGP-2500-3200 'NA) ($EQ AGP-2500-3200 'FALSE)))
    (ACTION
      '($SETQ SH-BO2 'NO)))

  (RULE012
    (TRANS
      '(if   accumulator gage pressure with system depressurized is
             between 2500 and 3200 psi is true
       then do set hydraulic boost 2 switch on))
    (PREMISE
      '($EQ AGP-2500-3200 'TRUE))
    (ACTION
      '(PROG ()
        (MSG 'CR
             "*****************************************************************"
             'CR
             "SET THE HYDRAULIC BOOST 2 SWITCH ON in the flight control"
             'CR
             "hydraulic system due to accumulator gage pressure abnormality"
             'CR
             "*****************************************************************"
             'CR)
       ($SETQ SH-BO2 'YES))))

  (RULE013
    (TRANS
      '(if   new pressure after electric circuit is disconnected is
             appr>ximately equal to old pressure is not applicable
       then accumulator gage pressure with system depressurized is
             between 2500 and 3200 psi is not applicable))
    (PREMISE
      '($EQ NP-EQ-P 'NA))
    (ACTION
      '($SETQ AGP-2500-3200 'NA)))

  (RULE014
    (TRANS
      '(if   new pressure after electric circuit is disconnected is
```

```
            approximately equal to old pressure is false
         then accumulator gage pressure with system depressurized is
            between 2500 and 3200 psi is false))
    (PREMISE
      '($EQ NP-EQ-P 'FALSE))
    (ACTION
      '($SETQ AGP-2500-3200 'FALSE)))

~ Rule 015 is to prevent search up NP-EQ-P if NP-2500-3200 is true.
~ If second parameter is true, then first parameter must be false.

  (RULE015
    (TRANS
      '(if   new pressure after electric circuit is disconnected is
            between 2500 and 3200 psi is true
       then new pressure after electric circuit is disconnected is
            approximately equal to old pressure is false))
    (PREMISE
      '($EQ NP-2500-3200 'TRUE))
    (ACTION
      '($SETQ NP-EQ-P 'FALSE)))


  (RULE016
    (TRANS
      '(if   pressure after auxiliary power unit start is between 450
            and 550 psi is not applicable
       then new pressure after electric circuit is disconnected is
            approximately equal to old pressure is not applicable))
    (PREMISE
      '($EQ P-450-550 'NA))
    (ACTION
      '($SETQ NP-EQ-P 'NA)))

  (RULE017
    (TRANS
      '(if   pressure after auxiliary power unit start is between 450
            and 550 psi is not false
       then new pressure after electric circuit is disconnected is
            approximately equal to old pressure is false))
    (PREMISE
      '($EQ P-450-550 'FALSE))
    (ACTION
      '($SETQ NP-EQ-P 'FALSE)))

  (RULE018
    (TRANS
      '(if   hydraulic boost off caution light on is not applicable
            or false
       then flight control manifold is ok))
    (PREMISE
      '(OR ($EQ HBF-1CL-ON 'NA) ($EQ HBF-1CL-ON 'FALSE)))
    (ACTION
      '($SETQ FCM 'OK)))

  (RULE019
    (TRANS
      '(if   hydraulic boost off caution light on is true
```

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       then flight control manifold has failed))
     (PREMISE
       '($EQ HBF-1CL-ON 'TRUE))
     (ACTION
       '(PROG ()
          (MSG 'CR
               "*****************************************************************"
               'CR
               "The FLIGHT CONTROL MANIFOLD in the flight control hydraulic"
               'CR
               "system has failed indicated by hydraulic boost off caution light"
               'CR
               "*****************************************************************"
               'CR)
          ($SETQ FCM 'FAILED))))

   (RULE020
     (TRANS
       '(if   hydraulic boost off caution light on is not applicable
              or true
        then trapped air at pressure transmittor is false))
     (PREMISE
       '(OR ($EQ HBF-1CL-ON 'NA) ($EQ HBF-1CL-ON 'TRUE)))
     (ACTION
       '($SETQ TA-AT-PT 'FALSE)))

   (RULE021
     (TRANS
       '(if   hydraulic boost off caution light on is false
        then trapped air at pressure transmittor is true))
     (PREMISE
       '($EQ HBF-1CL-ON 'FALSE))
     (ACTION
       '(PROG ()
          (MSG 'CR
               "*****************************************************************"
               'CR
               "There is TRAPPED AIR at the PRESSURE TRANSMITTER in the flight"
               'CR
               "control hydraulic system indicated by hydraulic boost off "
               'CR
               "caution light being off"
               'CR
               "*****************************************************************"
               'CR)
          ($SETQ TA-AT-PT 'TRUE))))

   (RULE022
     (TRANS
       '(if   new pressure after electric circuit is disconnected is
              approximately equal to old pressure is not applicable
        then hydraulic boost off caution light on is not applicable))
     (PREMISE
       '($EQ NP-EQ-P 'NA))
     (ACTION
       '($SETQ HBF-1CL-ON 'NA)))

   (RULE023
```

```
    (TRANS
      '(if   new pressure after electric circuit is disconnected is
             approximately equal to old pressure is false
       then hydraulic boost off caution light on is false))
    (PREMISE
      '($EQ NP-EQ-P 'FALSE))
    (ACTION
      '($SETQ HBF-1CL-ON 'FALSE)))

  (RULE024
    (TRANS
      '(if   pressure indication is not low or not applicable
        and pressure indication is not fluctuating or not applicable
       then pressure indicator is ok))
    (PREMISE
      '(AND (OR ($EQ PI-L 'NA) ($EQ PI-L 'FALSE))
            (OR ($EQ PI-F 'NA) ($EQ PI-F 'FALSE))))
    (ACTION
      '($SETQ PI 'OK)))

  (RULE025
    (TRANS
      '(if   pressure indication is low
         or  pressure indication is fluctuating
       then pressure indicator is failed))
    (PREMISE
      '(OR ($EQ PI-L 'TRUE) ($EQ PI-F 'TRUE)))
    (ACTION
      '(PROG ()
         (MSG 'CR
              "*****************************************************************"
              'CR
              "The PRESSURE INDICATOR in the flight control hydraulic system"
              'CR
              "has failed due to low or fluctuating pressure indication"
              'CR
              "*****************************************************************"
              'CR)
       ($SETQ PI 'FAILED))))

  (RULE026
    (TRANS
      '(if   hydraulic boost off caution light on is not applicable or
             true
       then pressure indication is low is not applicable))
    (PREMISE
      '(OR ($EQ HBF-1CL-ON 'NA) ($EQ HBF-1CL-ON 'TRUE)))
    (ACTION
      '($SETQ PI-L 'NA)))

  (RULE027
    (TRANS
      '(if   hydraulic boost off caution light on is not applicable or
             true
       then pressure indication is fluctuating is not applicable))
    (PREMISE
      '(OR ($EQ HBF-1CL-ON 'NA) ($EQ HBF-1CL-ON 'TRUE)))
    (ACTION
```

```
    '($SETQ PI-F 'NA)))

(RULE028
  (TRANS
    '(if   pressure indication is not low or not applicable
      and pressure indication is not fluctuating or not applicable
     then pressure transmitter 1 is ok))
  (PREMISE
    '(AND (OR ($EQ PI-L 'NA) ($EQ PI-L 'FALSE))
          (OR ($EQ PI-F 'NA) ($EQ PI-F 'FALSE))))
  (ACTION
    '($SETQ PT1 'OK)))

(RULE029
  (TRANS
    '(if   pressure indication is low or fluctuating is true
     then pressure transmittor 1 has failed))
  (PREMISE
    '(OR ($EQ PI-L 'TRUE) ($EQ PI-F 'TRUE)))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "**********************************************************************"
            'CR
            "The PRESSURE TRANSMITTER in the flight control hydraulic"
            'CR
            "system has failed due to low or fluctuating pressure indication"
            'CR
            "**********************************************************************"
            'CR)
     ($SETQ PT1 'FAILED))))

(RULE030
  (TRANS
    '(if   accumulator gage pressure is between 2500 and 3200 psi with
           system depressurized is not applicable or false
     then pressure transmittor 2 is ok))
  (PREMISE
    '(OR ($EQ AGP-2500-3200 'NA) ($EQ AGP-2500-3200 'FALSE)))
  (ACTION
    '($SETQ PT2 'OK)))

(RULE031
  (TRANS
    '(if   accumulator gage pressure is between 2500 and 3200 psi with
           system depressurized is true
     then pressure transmittor 2 is failed))
  (PREMISE
    '($EQ AGP-2500-3200 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "**********************************************************************"
            'CR
            "The PRESSURE TRANSMITTER in the flight control hydraulic"
            'CR
            "system has failed due to accumulator gage pressure indication"
            'CR
```

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              "between 2500 and 3200 psi"
              'CR
              "*****************************************************************"
              'CR)
       ($SETQ PT2 'FAILED))))

(RULE032
  (TRANS
    '(if   accumulator gage is fluctuating is not applicable or true
     then pressure transmittor 3 is ok))
  (PREMISE
    '(OR ($EQ AG-F 'NA) ($EQ AG-F 'TRUE)))
  (ACTION
    '($SETQ PT3 'OK)))

(RULE033
  (TRANS
    '(if   accumulator gage pressure is fluctuating is false
     then pressure transmittor 3 is failed))
  (PREMISE
    '($EQ AG-F 'FALSE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "The PRESSURE TRANSMITTER in the flight control hydraulic"
            'CR
            "system has failed due to nonfluctuating accumulator gage"
            'CR
            "pressure reading"
            'CR
            "*****************************************************************"
            'CR)
       ($SETQ PT3 'FAILED))))

(RULE034
  (TRANS
    '(if   hydraulic boost off caution light on is not applicable or
           true
     then pressure indication is low is not applicable))
  (PREMISE
    '(OR ($EQ HBF-1CL-ON 'NA) ($EQ HBF-1CL-ON 'TRUE)))
  (ACTION
    '($SETQ PI-L 'NA)))

(RULE035
  (TRANS
    '(if   hydraulic boost off caution light on is not applicable or
           true
     then pressure indication is fluctuating is not applicable))
  (PREMISE
    '(OR ($EQ HBF-1CL-ON 'NA) ($EQ HBF-1CL-ON 'TRUE)))
  (ACTION
    '($SETQ PI-F 'NA)))

(RULE036
  (TRANS
```

```
      '(if   pressure indication is high is false
       then accumulator gage pressure is between 2500 and 3200 psi
            is not applicable))
    (PREMISE
      '($EQ PH 'FALSE))
    (ACTION
      '($SETQ AGP-2500-3200 'NA)))

  (RULE037
    (TRANS
      '(if   trapped air at system is not applicable or false
       then accumulator gage pressure is fluctuating is not applicable))
    (PREMISE
      '(OR ($EQ TA-IN-SYS 'NA) ($EQ TA-IN-SYS 'FALSE)))
    (ACTION
      '($SETQ AG-F 'NA)))

  (RULE038
    (TRANS
      '(if   pressure indication is fluctuatingis false
       then trapped air at system is not applicable))
    (PREMISE
      '($EQ PFL 'FALSE))
    (ACTION
      '($SETQ TA-IN-SYS 'NA)))

  (RULE039
    (TRANS
      '(if   accumulator gage pressure indication is equal to cockpit
             pressure indication is not applicable or false
       then flight control pump 1 is ok))
    (PREMISE
      '(OR ($EQ AGP-EQ-P 'NA) ($EQ AGP-EQ-P 'FALSE)))
    (ACTION
      '($SETQ FCP1 'OK)))

  (RULE040
    (TRANS
      '(if   accumulator gage pressure indication is equal to cockpit
             pressure indication is true
       then flight control pump 1 is failed))
    (PREMISE
      '($EQ AGP-EQ-P 'TRUE))
    (ACTION
      '(PROG ()
         (MSG 'CR
              "*****************************************************************"
              'CR
              "The FLIGHT CONTROL PUMP in the flight control hydraulic"
              'CR
              "system has failed due to accumulator gage pressure"
              'CR
              "reading equal to cockpit pressure indication"
              'CR
              "*****************************************************************"
              'CR)
       ($SETQ FCP1 'FAILED))))
```

```
(RULE041
  (TRANS
    '(if   temperature of hose fitting at pump pressure port is
           greater than temperature of hose fitting at pump case
           drain port by 28 degrees celsius is not applicable or false
      and  temperature of hose fitting at pump case drain port
           is greater than 102 degrees celsius is not applicable or
           false
     then  flight control pump 2 is ok))
  (PREMISE
    '(AND (OR ($EQ AGB-28 'NA) ($EQ AGB-28 'FALSE))
          (OR ($EQ BG-102 'NA) ($EQ BG-102 'FALSE))))
  (ACTION
    '($SETQ FCP2 'OK)))

(RULE042
  (TRANS
    '(if   temperature of hose fitting at pump pressure port is
           greater than temperature of hose fitting at pump case
           drain port by 28 degrees celsius is true
      or   temperature of hose fitting at pump case drain port
           is greater than 102 degrees celsius is true
     then  flight control pump 2 is failed))
  (PREMISE
    '(OR ($EQ AGB-28 'TRUE) ($EQ BG-102 'TRUE)))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "The FLIGHT CONTROL PUMP in the flight control hydraulic"
            'CR
            "system has failed due to abnormal temperature reading"
            'CR
            "at hose fitting at pump pressure port"
            'CR
            "*****************************************************************"
            'CR)
     ($SETQ FCP2 'FAILED))))

(RULE043
  (TRANS
    '(if   temperature differential between inlet and outlet port
           of flight control pump is abnormal is not applicable or
           false
     then  flight control pump 3 is ok))
  (PREMISE
    '(OR ($EQ TDA-FCP 'NA) ($EQ TDA-FCP 'FALSE)))
  (ACTION
    '($SETQ FCP3 'OK)))

(RULE044
  (TRANS
    '(if   temperature differential between inlet and outlet port
           of flight control pump is abnormal is true
     then  flight control pump 3 is failed))
  (PREMISE
    '($EQ TDA-FCP 'TRUE))
```

```
    (ACTION
      '(PROG ()
         (MSG 'CR
              "**************************************************************"
              'CR
              "The FLIGHT CONTROL PUMP in the flight control hydraulic"
              'CR
              "system has failed due to abnormal temperature reading"
              'CR
              "at inlet and outlet of flight control pump"
              'CR
              "**************************************************************"
              'CR)
       ($SETQ FCP3 'FAILED))))

  (RULE045
    (TRANS
      '(if   pressure indication is high is false
       then accumulator gage pressure is equal to cockpit pressure
            indication is not applicable))
    (PREMISE
      '($EQ PH 'FALSE))
    (ACTION
      '($SETQ AGP-EQ-P 'NA)))

  (RULE046
    (TRANS
      '(if   pressure indication is low is false
        and pressure indication is zero is false
        and pressure indication is fluctuating is false
        and accumulator gage is fluctuating is either not applicable
            or false
       then temperature of hose fitting at pump pressure port is
            greater than temperature of hose fitting at pump case
            drain port by 28 degrees celsius))
    (PREMISE
      '(AND ($EQ PL 'FALSE) ($EQ PZ 'FALSE) ($EQ PFL 'FALSE)
            (OR ($EQ AG-F 'NA) ($EQ AG-F 'FALSE))))
    (ACTION
      '($SETQ AGB-28 'NA)))

  (RULE047
    (TRANS
      '(if   pressure indication is low is false
        and pressure indication is zero is false
        and pressure indication is fluctuating is false
        and accumulator gage is fluctuating is either not applicable
            or false
       then temperature of hose fitting at pump case drain port is
            greater than 102 degrees celsius is not applicable))
    (PREMISE
      '(AND ($EQ PL 'FALSE) ($EQ PZ 'FALSE) ($EQ PFL 'FALSE)
            (OR ($EQ AG-F 'NA) ($EQ AG-F 'FALSE))))
    (ACTION
      '($SETQ BG-102 'NA)))

  (RULE048
    (TRANS
```

```
      '(if   temperature of return line tube assembly at flight control
             manifold is greater than or equal to temperature of hose
             fitting at pump pressure port is not applicable or true
        then temperature differential between inlet and outlet port
             of flight control pump is abnormal is not applicable))
    (PREMISE
      '(OR ($EQ TC-GTE-TA 'NA) ($EQ TC-GTE-TA 'TRUE)))
    (ACTION
      '($SETQ TDA-FCP 'NA)))

  (RULE049
    (TRANS
      '(if   pressure indication is low is false
        then temperature of return line tube assembly at flight control
             manifold is greater than or equal to temperature of hose
             fitting at pump pressure port is not applicable))
    (PREMISE
      '($EQ PL 'FALSE))
    (ACTION
      '($SETQ TC-GTE-TA 'NA)))

  (RULE049-001
    (TRANS
      '(if   carbon-faced encased plain seal damaged is false or na
        then replace seals #4 in flight control pump is false))
    (PREMISE
      '(OR ($EQ CFEPS-FCP 'NA) ($EQ CFEPS-FCP 'FALSE)))
    (ACTION
      '($SETQ R-SEAL4-FCP 'FALSE)))

  (RULE049-002
    (TRANS
      '(if   carbon-faced encased plain seal damaged is true
        then replace seals #4 is true))
    (PREMISE
      '($EQ CFEPS-FCP 'TRUE))
    (ACTION
      '(PROG ()
         (MSG 'CR
              "*****************************************************************"
              'CR
              "REPLACE SEALS #4 in the flight control pump in the flight con-"
              'CR
              "trol hydraulic system due to damaged carbon-faced plain seal"
              'CR
              "*****************************************************************"
              'CR)
       ($SETQ R-SEAL4-FCP 'TRUE))))

  (RULE049-003
    (TRANS
      '(if   shaft seal #4 leaks is na
        then carbon faced encased plain seal damaged is na))
    (PREMISE
      '($EQ SSL4-FCP 'NA))
    (ACTION
      '($SETQ CFEPS-FCP 'NA)))
```

```
(RULE049-004
  (TRANS
    '(if   shaft seal #4 leaks is false
     then carbon faced encased plain seal damaged is false))
  (PREMISE
    '($EQ SSL4-FCP 'FALSE))
  (ACTION
    '($SETQ CFEPS-FCP 'FALSE)))

(RULE049-005
  (TRANS
    '(if   flight control pump is ok
     then shaft seal #4 leaks is false))
  (PREMISE
    '(AND ($EQ FCP1 'OK) ($EQ FCP2 'OK) ($EQ FCP3 'OK)))
  (ACTION
    '($SETQ SSL4-FCP 'FALSE)))

(RULE049-006
  (TRANS
    '(if   loose attaching parts in flight control pump is false or na
     then tighten bolts or screws in leaking areas is false))
  (PREMISE
    '(OR ($EQ LAP-FCP 'NA) ($EQ LAP-FCP 'FALSE)))
  (ACTION
    '($SETQ T-BOLTS-FCP 'FALSE)))

(RULE049-007
  (TRANS
    '(if   loose attaching parts in flight control pump is true
     then tighten bolts or screws in leaking areas is true))
  (PREMISE
    '($EQ LAP-FCP 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "TIGHTEN BOLTS OR SCREWS in leaking areas in the flight control"
            'CR
            "pump in the flight control hydraulic system due to leaking parts"
            'CR
            "*****************************************************************"
            'CR)
     ($SETQ T-BOLTS-FCP 'TRUE))))

(RULE049-008
  (TRANS
    '(if   external leakage in flight control pump is na
     then loose attaching parts in flight control pump is na))
  (PREMISE
    '($EQ EL-FCP 'NA))
  (ACTION
    '($SETQ LAP-FCP 'NA)))

(RULE049-009
  (TRANS
    '(if   external leakage in flight control pump is false
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      then loose attaching parts in flight control pump is false))
    (PREMISE
      '($EQ EL-FCP 'FALSE))
    (ACTION
      '($SETQ LAP-FCP 'FALSE)))

  (RULE049-010
    (TRANS
      '(if   flight control pump is ok
       then external leakage in flight control pump is false))
    (PREMISE
      '(AND ($EQ FCP1 'OK) ($EQ FCP2 'OK) ($EQ FCP3 'OK)))
    (ACTION
      '($SETQ EL-FCP 'FALSE)))

  (RULE049-011
    (TRANS
      '(if   damaged or twisted packings in flight control pump is na or false
       then replace the packings is false))
    (PREMISE
      '(OR ($EQ PACKING-FCP 'NA) ($EQ PACKING-FCP 'FALSE)))
    (ACTION
      '($SETQ R-PACKING-FCP 'FALSE)))

  (RULE049-012
    (TRANS
      '(if   damaged or twisted packings in flight control pump is true
       then replace the packings is true))
    (PREMISE
      '($EQ PACKING-FCP 'TRUE))
    (ACTION
      '(PROG ()
         (MSG 'CR
              "*****************************************************************"
              'CR
              "REPLACE THE PACKINGS in the flight control pump in the flight"
              'CR
              "control hydraulic system due to damaged or twisted packings"
              'CR
              "*****************************************************************"
              'CR)
       ($SETQ R-PACKING-FCP 'TRUE))))

  (RULE049-013
    (TRANS
      '(if   external leakage in flight control pump is na
       then damaged or twisted packings in flight control pump is na))
    (PREMISE
      '($EQ EL-FCP 'NA))
    (ACTION
      '($SETQ PACKING-FCP 'NA)))

  (RULE049-014
    (TRANS
      '(if   external leakage in flight control pump is false
       then damaged or twisted packings in flight control pump is false))
    (PREMISE
      '($EQ EL-FCP 'FALSE))
```

```
    (ACTION
      '($SETQ PACKING-FCP 'FALSE)))

  (RULE049-015
    (TRANS
      '(if   scoring or nicks on mating surfaces in flight control pump is
             na or false
       then replace the pump is false))
    (PREMISE
      '(OR ($EQ SNMATSUR-FCP 'NA) ($EQ SNMATSUR-FCP 'FALSE)))
    (ACTION
      '($SETQ R-PUMP1-FCP 'FALSE)))

  (RULE049-016
    (TRANS
      '(if   scoring or nicks on mating surfaces in flight control pump is
             true
       then replace the pump is true))
    (PREMISE
      '($EQ SNMATSUR-FCP 'TRUE))
    (ACTION
      '(PROG ()
         (MSG 'CR
              "*****************************************************************"
              'CR
              "REPLACE THE FLIGHT CONTROL PUMP in the flight control hydraulic"
              'CR
              "system due to scoring or nicks on the mating surface"
              'CR
              "*****************************************************************"
              'CR)
       ($SETQ R-PUMP1-FCP 'TRUE))))

  (RULE049-017
    (TRANS
      '(if   external leakage in flight control pump is na
       then scoring or nicks on mating surfaces is na))
    (PREMISE
      '($EQ EL-FCP 'NA))
    (ACTION
      '($SETQ SNMATSUR-FCP 'NA)))

  (RULE049-018
    (TRANS
      '(if   external leakage in flight control pump is false
       then scoring or nicks on mating surfaces is false))

    (PREMISE
      '($EQ EL-FCP 'FALSE))
    (ACTION
      '($SETQ SNMATSUR-FCP 'FALSE)))

  (RULE049-019
    (TRANS
      '(if   sticking compensator spring #11 or #12 in flight control
             pump is na or false
       then replace the pumps in the flight control pump is false))
    (PREMISE
```

```
    '(OR ($EQ SCOMPSPR1112-FCP 'NA) ($EQ SCOMPSPR1112-FCP 'FALSE)))
  (ACTION
    '($SETQ R-PUMP2-FCP 'FALSE)))

(RULE049-020
  (TRANS
    '(if   sticking compensator spring #11 or #12 in flight control
           pump is true
     then replace pumps in flight control pump is true))
  (PREMISE
    '($EQ SCOMPSPR1112-FCP 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*************************************************************"
            'CR
            "REPLACE THE FLIGHT CONTROL PUMP in the flight control hydraulic"
            'CR
            "system due to the sticking compensator spring #11 or #12"
            'CR
            "*************************************************************"
            'CR)
     ($SETQ R-PUMP2-FCP 'TRUE))))

(RULE049-021
  (TRANS
    '(if   excessive hunting, fluctuation or cavitation is na
     then sticking compensator spring #11 and #12 is na))
  (PREMISE
    '($EQ HFC-FCP 'NA))
  (ACTION
    '($SETQ SCOMPSPR1112-FCP 'NA)))

(RULE049-022
  (TRANS
    '(if   excessive hunting, fluctuation or cavitation is false
     then sticking compensator spring #11 and #12 is false))
  (PREMISE
    '($EQ HFC-FCP 'FALSE))
  (ACTION
    '($SETQ SCOMPSPR1112-FCP 'FALSE)))

(RULE049-023
  (TRANS
    '(if   flight control pump is ok
     then excessive hunting, fluctuation or cavitation is false))
  (PREMISE
    '(AND ($EQ FCP1 'OK) ($EQ FCP2 'OK) ($EQ FCP3 'OK)))
  (ACTION
    '($SETQ HFC-FCP 'FALSE)))

(RULE049-024
  (TRANS
    '(if   loose or sticking spool valve #13 in flight control pump
           is na or false
     then replace the pumps in the flight control pump is false))
  (PREMISE
    '(OR ($EQ LSSPOOLV13-FCP 'NA) ($EQ LSSPOOLV13-FCP 'FALSE)))
```

```
    (ACTION
      '($SETQ R-PUMP3-FCP 'FALSE)))

  (RULE049-025
    (TRANS
      '(if   loose or sticking spool valve #13 in flight control
             pump is true
       then replace pumps in flight control pump is true))
    (PREMISE
      '($EQ LSSPOOLV13-FCP 'TRUE))
    (ACTION
      '(PROG ()
         (MSG 'CR
              "*****************************************************************"
              'CR
              "REPLACE THE FLIGHT CONTROL PUMP in the flight control hydraulic"
              'CR
              "system due to loose or sticking spool valve #13"
              'CR
              "*****************************************************************"
              'CR)
       ($SETQ R-PUMP3-FCP 'TRUE))))

  (RULE049-026
    (TRANS
      '(if   excessive hunting, fluctuation or cavitation is na
             and low pressure in flight control pump is na
       then loose or sticking spool valve #13 is na))
    (PREMISE
      '(AND ($EQ HFC-FCP 'NA) ($EQ LP-FCP 'NA)))
    (ACTION
      '($SETQ LSSPOOLV13-FCP 'NA)))

  (RULE049-027
    (TRANS
      '(if   excessive hunting, fluctuation or cavitation is false
             and low pressure in flight control pump is false
       then loose or sticking spool valve #13 is false))
    (PREMISE
      '(AND ($EQ HFC-FCP 'FALSE) ($EQ LP-FCP 'FALSE)))
    (ACTION
      '($SETQ LSSPOOLV13-FCP 'FALSE)))

  (RULE049-028
    (TRANS
      '(if   flight control pump is ok
       then low pressure in flight control pump is false))
    (PREMISE
      '(AND ($EQ FCP1 'OK) ($EQ FCP2 'OK) ($EQ FCP3 'OK)))
    (ACTION
      '($SETQ LP-FCP 'FALSE)))

  (RULE049-028-1
    (TRANS
      '(if   low pressure in flight control pump is true
       then high pressure in flight control pump is false))
    (PREMISE
      '($EQ LP-FCP 'TRUE))
```

```
    (ACTION
      '($SETQ HP-FCP 'FALSE)))

  (RULE049-029
    (TRANS
      '(if   broken compensator spring #11 and #12 in flight control pump
             is na or false
       then replace the pumps in the flight control pump is false))
    (PREMISE
      '(OR ($EQ BCOMPSPR1112-FCP 'NA) ($EQ BCOMPSPR1112-FCP 'FALSE)))
    (ACTION
      '($SETQ R-PUMP4-FCP 'FALSE)))

  (RULE049-030
    (TRANS
      '(if   broken compensator spring #11 and #12 in flight control
             pump is true
       then replace pumps in flight control pump is true))
    (PREMISE
      '($EQ BCOMPSPR1112-FCP 'TRUE))
    (ACTION
      '(PROG ()
         (MSG 'CR
              "*****************************************************************"
              'CR
              "REPLACE THE FLIGHT CONTROL PUMP in the flight control hydraulic"
              'CR
              "system due to a broken compensator spring #11 and #12"
              'CR
              "*****************************************************************"
              'CR)
       ($SETQ R-PUMP4-FCP 'TRUE))))

  (RULE049-031
    (TRANS
      '(if   low pressure in flight control pump is na
       then broken compensator spring #11 and #12 in flight control
             pump is na))
    (PREMISE
      '($EQ LP-FCP 'NA))
    (ACTION
      '($SETQ BCOMPSPR1112-FCP 'NA)))

  (RULE049-032
    (TRANS
      '(if   low pressure in flight control pump is false
       then broken compensator sprint #11 and #12 in flight control pump
             is false))
    (PREMISE
      '($EQ LP-FCP 'FALSE))
    (ACTION
      '($SETQ BCOMPSPR1112-FCP 'FALSE)))

  (RULE049-033
    (TRANS
      '(if   faulty compensator action #14 is na or false
       then replace the pumps in the flight control pump is false))
    (PREMISE
```

```
      '(OR ($EQ FCOMPENSATOR14-FCP 'NA) ($EQ FCOMPENSATOR14-FCP 'FALSE)))
    (ACTION
      '($SETQ R-PUMP5-FCP 'FALSE)))

  (RULE049-034
    (TRANS
      '(if   faulty compensator action #14 is true
       then replace pumps in flight control pump is true))
    (PREMISE
      '($EQ FCOMPENSATOR14-FCP 'TRUE))
    (ACTION
      '(PROG ()
         (MSG 'CR
              "*****************************************************************"
              'CR
              "REPLACE THE FLIGHT CONTROL PUMP in the flight control hydraulic"
              'CR
              "system due to a faulty compensator action #14"
              'CR
              "*****************************************************************"
              'CR)
       ($SETQ R-PUMP5-FCP 'TRUE))))

  (RULE049-035
    (TRANS
      '(if   high pressure in flight control pump is na
       then faulty compensator action in flight control pump is na))
    (PREMISE
      '($EQ HP-FCP 'NA))
    (ACTION
      '($SETQ FCOMPENSATOR14-FCP 'NA)))

  (RULE049-036
    (TRANS
      '(if   high pressure in flight control pump is false
       then faulty compensator action in flight control pump is false))
    (PREMISE
      '($EQ HP-FCP 'FALSE))
    (ACTION
      '($SETQ FCOMPENSATOR14-FCP 'FALSE)))

  (RULE049-037
    (TRANS
      '(if   flight control pump is ok
       then high pressure in flight control pump is false))
    (PREMISE
      '(AND ($EQ FCP1 'OK) ($EQ FCP2 'OK) ($EQ FCP3 'OK)))
    (ACTION
      '($SETQ HP-FCP 'FALSE)))

  (RULE050
    (TRANS
      '(if   temperature of return line tube assembly at flight control
             manifold is greater than or equal to temperature of hose
             fitting at pump pressure port is not applicable
             or false
       then flight control manifold is ok))
    (PREMISE
```

```
    '(OR ($EQ TC-GTE-TA 'NA) ($EQ TC-GTE-TA 'FALSE)))
  (ACTION
    '($SETQ FCM 'OK)))

(RULE051
  (TRANS
    '(if   temperature of return line tube assembly at flight control
           manifold is greater than or equal to temperature of hose
           fitting at pump pressure port is true
     then  flight control manifold is failed))
  (PREMISE
    '($EQ TC-GTE-TA 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "FLIGHT CONTROL MANIFOLD in flight control hydraulic system has"
            'CR
            "failed due to high temperature of return line tube assembly at"
            'CR
            "flight control manifold"
            'CR
            "*****************************************************************"
            'CR)
     ($SETQ FCM 'FAILED))))

(RULE052
  (TRANS
    '(if   temperature differential between inlet and outlet port
           of pressure reduce valve is abnormal is not applicable
           or false
     then  pressure reduce valve is ok))
  (PREMISE
    '(OR ($EQ TDA-PRV 'NA) ($EQ TDA-PRV 'FALSE)))
  (ACTION
    '($SETQ PRV 'OK)))

(RULE053
  (TRANS
    '(if   temperature differential between inlet and outlet port
           of pressure reduce valve is abnormal is true
     then  pressure reduce valve has failed))
  (PREMISE
    '($EQ TDA-PRV 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "PRESSURE REDUCE VALVE in flight control hydraulic system"
            'CR
            "has failed due to abnormal temperature differential between"
            'CR
            "inlet and outlet of pressure reduce valve"
            "*****************************************************************"
            'CR)
     ($SETQ PRV 'FAILED))))
```

```
(RULE054
  (TRANS
    '(if   temperature differential between inlet and outlet port
           of flight boost accumulator is abnormal is not applicable
           or false
     then  flight boost accumulator is ok))
  (PREMISE
    '(OR ($EQ TDA-FBA 'NA) ($EQ TDA-FBA 'FALSE)))
  (ACTION
    '($SETQ FBA 'OK)))

(RULE055
  (TRANS
    '(if   temperature differential between inlet and outlet port
           of flight boost accumulator is abnormal is true
     then  flight boost accumulator has failed))
  (PREMISE
    '($EQ TDA-FBA 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "FLIGHT BOOST ACCUMULATOR in flight control hydraulic system"
            'CR
            "has failed due to abnormal temperature differential between "
            'CR
            "inlet and outlet port of flight boost accumulator"
            'CR
            "*****************************************************************"
            'CR)
     ($SETQ FBA 'FAILED))))

(RULE056
  (TRANS
    '(if   temperature differential between inlet and outlet port
           of hydraulic tank is abnormal is not applicable
           or false
     then  hydraulic tank is ok))
  (PREMISE
    '(OR ($EQ TDA-HT 'NA) ($EQ TDA-HT 'FALSE)))
  (ACTION
    '($SETQ HT 'OK)))

(RULE057
  (TRANS
    '(if   temperature differential between inlet and outlet port
           of hydraulic tank is abnormal is true
     then  hydraulic tank has failed))
  (PREMISE
    '($EQ TDA-HT 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "HYDRAULIC TANK in flight control hydraulic system"
```

```
              'CR
              "has failed due to abnormal temperature differential between"
              'CR
              "inlet and outlet port of hydraulic tank"
              'CR
              "*****************************************************************"
              'CR)
      ($SETQ HT 'FAILED))))

(RULE058
  (TRANS
    '(if   temperature differential between inlet and outlet port
           of pressure filter is abnormal is not applicable
           or false
     then  pressure filter is ok))
  (PREMISE
    '(OR ($EQ TDA-PF 'NA) ($EQ TDA-PF 'FALSE)))
  (ACTION
    '($SETQ PF 'OK)))

(RULE059
  (TRANS
    '(if   temperature differential between inlet and outlet port
           of pressure filter is abnormal is true
     then  pressure filter has failed))
  (PREMISE
    '($EQ TDA-PF 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "The PRESSURE FILTER in flight control hydraulic system"
            'CR
            "has failed due to abnormal temperature differential between"
            'CR
            "inlet and outlet port of pressure filter"
            'CR
            "*****************************************************************"
            'CR)
      ($SETQ PF 'FAILED))))

(RULE060
  (TRANS
    '(if   temperature differential between inlet and outlet port
           of return filter is abnormal is not applicable
           or false
     then  return filter is ok))
  (PREMISE
    '(OR ($EQ TDA-RF 'NA) ($EQ TDA-RF 'FALSE)))
  (ACTION
    '($SETQ RF 'OK)))

(RULE061
  (TRANS
    '(if   temperature differential between inlet and outlet port
           of return filter is abnormal is true
     then  return filter has failed))
```

```
    (PREMISE
      '($EQ TDA-RF 'TRUE))
    (ACTION
      '(PROG ()
         (MSG 'CR
              "**********************************************************************"
              'CR
              "The RETURN FILTER in the flight control hydraulic system"
              'CR
              "has failed due to abnormal temperature differential between"
              'CR
              "inlet and outlet port of return filter"
              'CR
              "**********************************************************************"
              'CR)
         ($SETQ RF 'FAILED))))

  (RULE062
    (TRANS
      '(if   temperature of return line tube assembly at flight control
             manifold is greater than or equal to temperature of hose
             fitting at pump pressure port is not applicable or true
       then  temperature differential between inlet and outlet port
             of pressure reduce valve is abnormal is not applicable))
    (PREMISE
      '(OR ($EQ TC-GTE-TA 'NA) ($EQ TC-GTE-TA 'TRUE)))
    (ACTION
      '($SETQ TDA-PRV 'NA)))

  (RULE063
    (TRANS
      '(if   temperature of return line tube assembly at flight control
             manifold is greater than or equal to temperature of hose
             fitting at pump pressure port is not applicable or true
       then  temperature differential between inlet and outlet port
             of flight boost accumulator is abnormal is not applicable))
    (PREMISE
      '(OR ($EQ TC-GTE-TA 'NA) ($EQ TC-GTE-TA 'TRUE)))
    (ACTION
      '($SETQ TDA-FBA 'NA)))

  (RULE064
    (TRANS
      '(if   temperature of return line tube assembly at flight control
             manifold is greater than or equal to temperature of hose
             fitting at pump pressure port is not applicable or true
       then  temperature differential between inlet and outlet port
             of hydraulic tank is abnormal is not applicable))
    (PREMISE
      '(OR ($EQ TC-GTE-TA 'NA) ($EQ TC-GTE-TA 'TRUE)))
    (ACTION
      '($SETQ TDA-HT 'NA)))

  (RULE065
    (TRANS
      '(if   temperature of return line tube assembly at flight control
             manifold is greater than or equal to temperature of hose
             fitting at pump pressure port is not applicable or true
```

```
      then  temperature differential between inlet and outlet port
            of pressure filter is abnormal is not applicable))
    (PREMISE
      '(OR ($EQ TC-GTE-TA 'NA) ($EQ TC-GTE-TA 'TRUE)))
    (ACTION
      '($SETQ TDA-PF 'NA)))

  (RULE066
    (TRANS
      '(if   temperature of return line tube assembly at flight control
             manifold is greater than or equal to temperature of hose
             fitting at pump pressure port is not applicable or true
       then  temperature differential between inlet and outlet port
             of return filter is abnormal is not applicable))
    (PREMISE
      '(OR ($EQ TC-GTE-TA 'NA) ($EQ TC-GTE-TA 'TRUE)))
    (ACTION
      '($SETQ TDA-RF 'NA)))

  (RULE066-001
    (TRANS
      '(if   static leakage in pressure reducing valve 238 is na or false
        then cycle the affected system long enough to moisten the seals
             is false))
    (PREMISE
      '(OR ($EQ S-L-PRV238 'NA) ($EQ S-L-PRV238 'FALSE)))
    (ACTION
      '($SETQ CYCLE-SYSTEM-PRV238 'FALSE)))

  (RULE066-002
    (TRANS
      '(if   static leakage in pressure reducing valve 238 is true
        then cycle the affected system long enough to moisten the seals
             is true))
    (PREMISE
      '($EQ S-L-PRV238 'TRUE))
    (ACTION
      '(PROG ()
         (MSG 'CR
              "**************************************************************"
              'CR
              "CYCLE the affected system long enough to moisten the seals"
              'CR
              "in the pressure reducing valve 238 due to static leakage"
              'CR
              "**************************************************************"
              'CR)
       ($SETQ CYCLE-SYSTEM-PRV238 'TRUE))))

  (RULE066-003
    (TRANS
      '(if   external leakage in pressure reducing valve is na
        then static leakage in pressure reducing valve 238 is na))
    (PREMISE
      '($EQ E-L-PRV238 'NA))
    (ACTION
      '($SETQ S-L-PRV238 'NA)))
```

```
(RULE066-004
  (TRANS
    '(if   external leakage in pressure reducing valve 238 is false
     then static leakage in pressure reducing valve 238 is false))
  (PREMISE
    '($EQ E-L-PRV238 'FALSE))
  (ACTION
    '($SETQ S-L-PRV238 'FALSE)))

(RULE066-005
  (TRANS
    '(if   pressure reducing valve 02, or 03 or 08 is ok
     then external leakage in pressure reducing valve 238 is false))
  (PREMISE
    '($EQ PRV238 'OK))
  (ACTION
    '($SETQ E-L-PRV238 'FALSE)))

(RULE066-006
  (TRANS
    '(if   pressure reducing valve is ok
     then pressure reducing valve 238 is ok))
  (PREMISE
    '($EQ PRV 'OK))
  (ACTION
    '($SETQ PRV238 'OK)))

(RULE066-007
  (TRANS
    '(if   damaged or incorrectly installed packing #2 is na or false
     then replace packing #2 in pressure reducing valve 238 is false))
  (PREMISE
    '(OR ($EQ PACKING2-PRV238 'NA) ($EQ PACKING2-PRV238 'FALSE)))
  (ACTION
    '($SETQ R-PACKING2-PRV238 'FALSE)))

(RULE066-008
  (TRANS
    '(if   damaged or incorrectly installed packing #2 is true
     then replace packing #2 in pressure reducing valve is true))
  (PREMISE
    '($EQ PACKING2-PRV238 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "REPLACE PACKING #2 in the pressure reducing valve 238"
            'CR
            "in flight control hydraulic system due to damaged packing"
            'CR
            "*****************************************************************"
            'CR)
     ($SETQ R-PACKING2-PRV238 'TRUE))))

(RULE066-009
  (TRANS
    '(if   external leakage and leakage at reseat exceeds specified
```

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          limit in pressure reducing valve are both na
       then packing #2 is damaged or incorrectly installed is na))
  (PREMISE
    '(AND ($EQ E-L-PRV238 'NA) ($EQ LEAKAGE-RESEAT-PRV238 'NA)))
  (ACTION
    '($SETQ PACKING2-PRV238 'NA)))

(RULE066-010
  (TRANS
    '(if   external leakage and leakage are reseat exceeds specified
          limit in pressure reducing valve are both false
     then packing #2 is damaged or incorrectly installed is false))
  (PREMISE
    '(AND ($EQ E-L-PRV238 'FALSE) ($EQ LEAKAGE-RESEAT-PRV238 'FALSE)))
  (ACTION
    '($SETQ PACKING2-PRV238 'FALSE)))

(RULE066-011
  (TRANS
    '(if   pressure reducing valve 02, or 03 or 08 is ok
     then leakage at reseat exceeds specified limit in pressure
          reducing valve 238 is false))
  (PREMISE
    '($EQ PRV238 'OK))
  (ACTION
    '($SETQ LEAKAGE-RESEAT-PRV238 'FALSE)))

(RULE066-012
  (TRANS
    '(if   incorrectly adjusted relief valve #8 in pressure reducing
          valve is na or false
     then adjust relief valve #8 in pressure reducing valve is false))
  (PREMISE
    '(OR ($EQ IADJ-REL-VAL8-PRV238 'NA) ($EQ IADJ-REL-VAL8-PRV238 'FALSE)))
  (ACTION
    '($SETQ A-REL-VAL8-PRV238 'FALSE)))

(RULE066-013
  (TRANS
    '(if   incorrectly adjusted relief valve #8 in pressure reducing
          valve is true
     then adjust relief valve #8 in pressure reducing valve is true))
  (PREMISE
    '($EQ IADJ-REL-VAL8-PRV238 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "ADJUST RELIEF VALVE #8 in the pressure reducing valve 238"
            'CR
            "in flight control hydraulic system due to incorrectly adjusted"
            'CR
            "relief valve"
            'CR
            "*****************************************************************"
            'CR)
     ($SETQ A-REL-VAL8-PRV238 'TRUE))))
```

```
(RULE066-014
  (TRANS
    '(if   relief flow from return port is not within specified limit is na
     then incorrectly adjusted relief valve #8 is na))
  (PREMISE
    '($EQ RET-PORT-PRV238 'NA))
  (ACTION
    '($SETQ IADJ-REL-VAL8-PRV238 'NA)))

(RULE066-015
  (TRANS
    '(if   relief flow from return port is not within specified limit is
           false
     then incorrectly adjusted relief valve #8 is false))
  (PREMISE
    '($EQ RET-PORT-PRV238 'FALSE))
  (ACTION
    '($SETQ IADJ-REL-VAL8-PRV238 'FALSE)))

(RULE066-016
  (TRANS
    '(if   pressure reducing valve 02, or 03 or 08 is ok
     then relief flow from return port is not within specified limit is
           false))
  (PREMISE
    '($EQ PRV238 'OK))
  (ACTION
    '($SETQ RET-PORT-PRV238 'FALSE)))

(RULE066-017
  (TRANS
    '(if   faulty relief valve #8 in pressure reducing valve is na or false
     then replace relief valve #8 assembly as a matched set is false))
  (PREMISE
    '(OR ($EQ F-REL-VAL8-PRV238 'NA) ($EQ F-REL-VAL8-PRV238 'FALSE)))
  (ACTION
    '($SETQ R-REL-VAL8-PRV238 'FALSE)))

(RULE066-018
  (TRANS
    '(if   faulty relief valve #8 in pressure reducing valve is true
     then replace relief valve #8 as a matched set is true))
  (PREMISE
    '($EQ F-REL-VAL8-PRV238 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "REPLACE RELIEF VALVE #8 in the pressure reducing valve 238"
            'CR
            "in flight control hydraulic system due to faulty relief valve"
            'CR
            "*****************************************************************"
            'CR)
     ($SETQ R-REL-VAL8-PRV238 'TRUE))))
```

```
(RULE066-019
  (TRANS
    '(if   relief flow from return port is not within specified limits
           and leakage at reseat exceeds specified limits are na
     then faulty relief valve #8 is na))
  (PREMISE
    '(AND ($EQ RET-PORT-PRV238 'NA) ($EQ LEAKAGE-RESEAT-PRV238 'NA)))
  (ACTION
    '($SETQ F-REL-VAL8-PRV238 'NA)))

(RULE066-020
  (TRANS
    '(if   relief flow from return port is not within specified limits
           and leakage at reseat exceeds specified limits are false
     then faulty relief valve #8 is false))
  (PREMISE
    '(AND ($EQ RET-PORT-PRV238 'FALSE) ($EQ LEAKAGE-RESEAT-PRV238 'FALSE)))
  (ACTION
    '($SETQ F-REL-VAL8-PRV238 'FALSE)))

(RULE066-021
  (TRANS
    '(if   faulty spring #13 is na or false
     then replace spring #13 in pressure reducing valve is false))
  (PREMISE
    '(OR ($EQ SPRING13-PRV238 'NA) ($EQ SPRING13-PRV238 'FALSE)))
  (ACTION
    '($SETQ R-SPRING13-PRV238 'FALSE)))

(RULE066-022
  (TRANS
    '(if   faulty spring #13 is true
     then replace spring #13 in pressure reducing valve is true))
  (PREMISE
    '($EQ SPRING13-PRV238 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "REPLACE SPRING #13 in the pressure reducing valve 238"
            'CR
            "in flight control hydraulic system due to faulty spring"
            'CR
            "*****************************************************************"
            'CR)
     ($SETQ R-SPRING13-PRV238 'TRUE))))

(RULE066-023
  (TRANS
    '(if   leakage at reseat exceeds specified limit in pressure
           reducing valve is na
     then faulty spring #13 is na))
  (PREMISE
    '($EQ LEAKAGE-RESEAT-PRV238 'NA))
  (ACTION
    '($SETQ SPRING13-PRV238 'NA)))
```

```
(RULE066-024
  (TRANS
    '(if   leakage at reseat exceeds specified limit in pressure reducing
           valve is false
     then faulty spring #13 is false))
  (PREMISE
    '($EQ LEAKAGE-RESEAT-PRV238 'FALSE))
  (ACTION
    '($SETQ SPRING13-PRV238 'FALSE)))

(RULE066-025
  (TRANS
    '(if   incorrectly adjusted reducer valve #12 is na or false
     then adjust reducer valve #12 in pressure reducing valve 238 is
           false))
  (PREMISE
    '(OR ($EQ REDUCER-VAL12-PRV238 'NA) ($EQ REDUCER-VAL12-PRV238 'FALSE)))
  (ACTION
    '($SETQ A-RED-VAL12-PRV238 'FALSE)))

(RULE066-026
  (TRANS
    '(if   incorrectly adjusted reducer valve #12 is true
     then adjust reducer valve #12 in pressure reducing valve 238 is
           true))
  (PREMISE
    '($EQ REDUCER-VAL12-PRV238 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "ADJUST REDUCER VALVE #12 in the pressure reducing valve 238"
            'CR
            "in flight control hydraulic system due to incorrectly adjusted"
            'CR
            "reducer valve"
            "*****************************************************************"
            'CR)
     ($SETQ A-RED-VAL12-PRV238 'TRUE))))

(RULE066-027
  (TRANS
    '(if   flow from reg port not within specified limits is na
     then incorrectly adjusted reducer valve #12 is na))
  (PREMISE
    '($EQ REG-PORT-PRV238 'NA))
  (ACTION
    '($SETQ REDUCER-VAL12-PRV238 'NA)))

(RULE066-028
  (TRANS
    '(if   flow from reg port not within specified limits is false
     then incorrectly adjusted reducer valve #12 is false))
  (PREMISE
    '($EQ REG-PORT-PRV238 'FALSE))
  (ACTION
    '($SETQ REDUCER-VAL12-PRV238 'FALSE)))
```

```
(RULE066-029
  (TRANS
    '(if   pressure reduce valve 238 is ok
     then flow from reg port not within specified limit is false))
  (PREMISE
    '($EQ PRV238 'OK))
  (ACTION
    '($SETQ REG-PORT-PRV238 'FALSE)))

(RULE066-030
  (TRANS
    '(if   faulty poppet #21 and sleeve assembly #22 is na or false
     then replace poppet #21 and sleeve assembly #22 in pressure
          reducing valve 238 is false))
  (PREMISE
    '(OR ($EQ POPPET21-SLEEVE22-PRV238 'NA)
         ($EQ POPPET21-SLEEVE22-PRV238 'FALSE)))
  (ACTION
    '($SETQ R-POPPET21-SLEEVE22-PRV238 'FALSE)))

(RULE066-031
  (TRANS
    '(if   faulty poppet #21 and sleeve assembly #22 is true
     then replace poppet #21 and sleeve assembly #22 in pressure
          reducing valve 238 is true))
  (PREMISE
    '($EQ POPPET21-SLEEVE22-PRV238 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*************************************************************"
            'CR
            "REPLACE POPPET #21 AND SLEEVE ASSEMBLY #22 in pressure"
            'CR
            "reducing valve 238 in flight control hydraulic system"
            'CR
            "due to faulty poppet and sleeve assembly"
            'CR
            "*************************************************************"
            'CR)
     ($SETQ R-POPPET21-SLEEVE22-PRV238 'TRUE))))

(RULE066-032
  (TRANS
    '(if   flow from reg port not within specified limit and leakage
           from ret port exceeds specified limit are na
     then poppet #21 and sleeve assembly #22 are faulty is na))
  (PREMISE
    '(AND ($EQ REG-PORT-PRV238 'NA) ($EQ L-RET-PORT-PRV238 'NA)))
  (ACTION
    '($SETQ POPPET21-SLEEVE22-PRV238 'NA)))

(RULE066-033
  (TRANS
    '(if   flow from reg port not within specified limit and leakage
           from ret port exceeds specified limit are false
     then poppet #21 and sleeve assembly #22 are faulty is false))
```

```
    (PREMISE
      '(AND ($EQ REG-PORT-PRV238 'FALSE) ($EQ L-RET-PORT-PRV238 'FALSE)))
    (ACTION
      '($SETQ POPPET21-SLEEVE22-PRV238 'FALSE)))

  (RULE066-034
    (TRANS
      '(if   pressure reduce valve 238 is ok
       then leakage from ret port exceeds specified limit is false))
    (PREMISE
      '($EQ PRV238 'OK))
    (ACTION
      '($SETQ L-RET-PORT-PRV238 'FALSE)))

  (RULE066-035
    (TRANS
      '(if   damaged or incorrectly installed packings #19 and #23 is na or
             false
       then replace packings #19 and #23))
    (PREMISE
      '(OR ($EQ PACKING1923-PRV238 'NA) ($EQ PACKING1923-PRV238 'FALSE)))
    (ACTION
      '($SETQ R-PACKING1923-PRV238 'FALSE)))

  (RULE066-036
    (TRANS
      '(if   damaged or incorrectly installed packings #19 and #23 is true
       then replace packings #19 and #23 is true))
    (PREMISE
      '($EQ PACKING1923-PRV238 'TRUE))
    (ACTION
      '(PROG ()
         (MSG 'CR
              "*****************************************************************"
              'CR
              "REPLACE PACKINGS #19 and #23 in pressure reducing valve 238"
              'CR
              "in flight control hydraulic system due to damaged or incorrectly"
              'CR
              "installed packings"
              'CR
              "*****************************************************************"
              'CR)
       ($SETQ R-PACKING1923-PRV238 'TRUE))))

  (RULE066-037
    (TRANS
      '(if   leakage from ret port exceeds specified limit is na
       then damaged or incorrectly installed packing #19 and #23 is na))
    (PREMISE
      '($EQ L-RET-PORT-PRV238 'NA))
    (ACTION
      '($SETQ PACKING1923-PRV238 'NA)))

  (RULE066-038
    (TRANS
      '(if   leakage from ret port exceeds specified limit is false
       then damaged or incorrectly installed packing #19 and #23 is false))
```

```
    (PREMISE
      '($EQ L-RET-PORT-PRV238 'FALSE))
    (ACTION
      '($SETQ PACKING1923-PRV238 'FALSE)))

  (RULE066-039
    (TRANS
      '(if   damaged packing #4 or #10 in pressure reducing valve 3011 is
             na or false
       then replace packing #4 or #10 in pressure reducing valve 3011
             is false))
    (PREMISE
      '(OR ($EQ PACKING410-PRV3A 'NA) ($EQ PACKING410-PRV3A 'FALSE)))
    (ACTION
      '($SETQ R-PACKING410-PRV3A 'FALSE)))

  (RULE066-040
    (TRANS
      '(if   damaged packing #4 or #10 in pressure reducing valve 3011 is true
       then replace packing #4 or #10 in pressure reducing valve is true))
    (PREMISE
      '($EQ PACKING410-PRV3A 'TRUE))
    (ACTION
      '(PROG ()
         (MSG 'CR
              "*****************************************************************"
              'CR
              "REPLACE PACKINGS #4 and #10 in pressure reducing valve 3A011"
              'CR
              "in flight control hydraulic system due to damaged packing"
              'CR
              "*****************************************************************"
              'CR)
       ($SETQ R-PACKING410-PRV3A 'TRUE))))

  (RULE066-041
    (TRANS
      '(if   external leakage in pressure reducing valve 3011 is na
       then damaged packing #4 or #10 in pressure reduce valve 3011 is na))
    (PREMISE
      '($EQ E-L-PRV3A 'NA))
    (ACTION
      '($SETQ PACKING410-PRV3A 'NA)))

  (RULE066-042
    (TRANS
      '(if   external leakage in pressure reducing valve 3011 is false
       then damaged packing #4 or #10 in pressure reducing valve 3011 is
             false))
    (PREMISE
      '($EQ E-L-PRV3A 'FALSE))
    (ACTION
      '($SETQ PACKING410-PRV3A 'FALSE)))

  (RULE066-043
    (TRANS
      '(if   pressure reducing valve 3011 is ok
       then external leakage in pressure reducing valve 3011 is false))
```

```
    (PREMISE
      '($EQ PRV3A 'OK))
    (ACTION
      '($SETQ E-L-PRV3A 'FALSE)))

  (RULE066-044
    (TRANS
      '(if   pressure reducing valve is ok
       then pressure reducing valve 3011 is ok))
    (PREMISE
      '($EQ PRV 'OK))
    (ACTION
      '($SETQ PRV3A 'OK)))

  (RULE066-045
    (TRANS
      '(if   incorrectly assembled backup rings #3 or #9 in pressure reduce
             valve 3011 is na or false
       then remove and reassemble backup ring #3 or #9 in pressure reduce
             valve 3011 is false))
    (PREMISE
      '(OR ($EQ RING39-PRV3A 'NA) ($EQ RING39-PRV3A 'FALSE)))
    (ACTION
      '($SETQ R-RING39-PRV3A 'FALSE)))

  (RULE066-046
    (TRANS
      '(if   incorrectly assembled backup rings #3 or #9 in pressure reduce
             valve 3011 is true
       then remove and reassemble backup ring #3 or #9 in pressure reduce
             valve 3011 is true))
    (PREMISE
      '($EQ RING39-PRV3A 'TRUE))
    (ACTION
      '(PROG ()
         (MSG 'CR
              "*****************************************************************"
              'CR
              "REMOVE AND REASSEMBLE BACKUP RING #3 OR #9 in pressure reducing"
              'CR
              "valve 3A011 in flight control hydraulic system due to incorrecly"
              'CR
              "assembled backup ring"
              'CR
              "*****************************************************************"
              'CR)
       ($SETQ R-RING39-PRV3A 'TRUE))))

  (RULE066-047
    (TRANS
      '(if   external leakage in pressure reducing valve 3011 is na
       then incorrectly assembled ring #3 or #9 in pressure reduce valve
             3011 is na))
    (PREMISE
      '($EQ E-L-PRV3A 'NA))
    (ACTION
      '($SETQ RING39-PRV3A 'NA)))
```

```
(RULE066-048
  (TRANS
    '(if   external leakage in pressure reducing valve 3011 is false
     then incorrectly assembled ring #3 or #9 in pressure reduce valve
          3011 is false))
  (PREMISE
    '($EQ E-L-PRV3A 'FALSE))
  (ACTION
    '($SETQ RING39-PRV3A 'FALSE)))

(RULE066-049
  (TRANS
    '(if   damaged packing #21 or #23 in pressure reducing valve 3011 is
          na or false
     then replace packing #21 or #23 in pressure reducing valve 3011
          is false))
  (PREMISE
    '(OR ($EQ PACKING2123-PRV3A 'NA) ($EQ PACKING2123-PRV3A 'FALSE)))
  (ACTION
    '($SETQ R-PACKING2123-PRV3A 'FALSE)))

(RULE066-050
  (TRANS
    '(if   damaged packing #21 or #23 in pressure reducing valve 3011 is true
     then replace packing #21 or #23 in pressure reducing valve is true))
  (PREMISE
    '($EQ PACKING2123-PRV3A 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "**********************************************************************"
            'CR
            "REPLACE PACKING #21 OR #23 in pressure reducing"
            'CR
            "valve 3A011 in flight control hydraulic system"
            'CR
            "due to damaged packing"
            'CR
            "**********************************************************************"
            'CR)
     ($SETQ R-PACKING2123-PRV3A 'TRUE))))

(RULE066-051
  (TRANS
    '(if   excessive internal leakage through return port in pressure reduce
          valve 3011 is na
     then damaged packing #21 or #23 in pressure reduce valve 3011 is na))
  (PREMISE
    '($EQ EX-L-RETPORT-PRV3A 'NA))
  (ACTION
    '($SETQ PACKING2123-PRV3A 'NA)))

(RULE066-052
  (TRANS
    '(if   excessive internal leakage through return port in pressure reduce
          valve 3011 is false
     then damaged packing #21 or #230 in pressure reducing valve 3011 is
          false))
```

```
    (PREMISE
      '($EQ EX-L-RETPORT-PRV3A 'FALSE))
    (ACTION
      '($SETQ PACKING2123-PRV3A 'FALSE)))

  (RULE066-053
    (TRANS
      '(if   pressure reducing valve 3011 is ok
       then excessive internal leakage through return port in pressure reduce
            valve 3011 is false))
    (PREMISE
      '($EQ PRV3A 'OK))
    (ACTION
      '($SETQ EX-L-RETPORT-PRV3A 'FALSE)))

  (RULE066-054
    (TRANS
      '(if   incorrectly assembled backup ring #20 in pressure reduce valve
            3011 is na or false
       then remove and reassemble backup ring #20 in pressure reduce valve
            3011 is false))
    (PREMISE
      '(OR ($EQ RING20-PRV3A 'NA) ($EQ RING20-PRV3A 'FALSE)))
    (ACTION
      '($SETQ R-RING20-PRV3A 'FALSE)))

  (RULE066-055
    (TRANS
      '(if   incorrectly assembled backup ring #20 in pressure reduce valve
            3011 is true
       then remove and reassemble backup ring #20 in pressure reduce valve
            3011 is true))
    (PREMISE
      '($EQ RING20-PRV3A 'TRUE))
    (ACTION
      '(PROG ()
         (MSG 'CR
              "*****************************************************************"
              'CR
              "REMOVE AND REASSEMBLE BACKUP RING #20 in pressure reducing"
              'CR
              "valve 3A011 in flight control hydraulic system"
              'CR
              "due to incorrectly assembled backup ring"
              'CR
              "*****************************************************************"
              'CR)
       ($SETQ R-RING20-PRV3A 'TRUE))))

  (RULE066-056
    (TRANS
      '(if   excessive flow thru return port during leakage test in pressure
            reduce valve 3011 is na
       then incorrectly assembled backup ring #20 is na))
    (PREMISE
      '($EQ EX-FLOW-RETPORT-PRV3A 'NA))
    (ACTION
      '($SETQ RING20-PRV3A 'NA)))
```

```
(RULE066-057
  (TRANS
    '(if   excessive flow thru return port during leakage test in pressure
           reduce valve 3011 is false
     then incorrectly assembled backup ring #20 is false))
  (PREMISE
    '($EQ EX-FLOW-RETPORT-PRV3A 'FALSE))
  (ACTION
    '($SETQ RING20-PRV3A 'FALSE)))

(RULE066-058
  (TRANS
    '(if   pressure reducing valve 3011 is ok
     then excessive flow thru return port during leakage test in pressure
           reduce valve 3011 is false))
  (PREMISE
    '($EQ PRV3A 'OK))
  (ACTION
    '($SETQ EX-FLOW-RETPORT-PRV3A 'FALSE)))

(RULE066-059
  (TRANS
    '(if   integral relief valve cracks due to pressure build-up caused by
           leakage through seat on barrel #15 in pressure reduce valve 3011
           is na or false
     then replace plunger #14 and barrel #15 in pressure reduce valve
           3011 is false))
  (PREMISE
    '(OR ($EQ PLUNGER14-BARREL15-PRV3A 'NA)
         ($EQ PLUNGER14-BARREL15-PRV3A 'FALSE)))
  (ACTION
    '($SETQ R-PLUNGER14-BARREL15-PRV3A 'FALSE)))

(RULE066-060
  (TRANS
    '(if   integral relief valve cracks due to pressure build-up caused by
           leakage through seat on barrel #15 in pressure reduce valve 3011
           is true
     then replace plunger #14 and barrel #15 in pressure reduce valve
           3011 is true))
  (PREMISE
    '($EQ PLUNGER14-BARREL15-PRV3A 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "REPLACE PLUNGER #14 AND BARREL #15 in pressure reducing"
            'CR
            "valve 3A011 in flight control hydraulic system due to integral"
            'CR
            "relief valve crack"
            'CR
            "*****************************************************************"
            'CR)
     ($SETQ R-PLUNGER14-BARREL15-PRV3A 'TRUE))))
```

```
(RULE066-061
  (TRANS
    '(if   excessive flow thru return port during leakage test in pressure
           reduce valve 3011 is na
     then integral relief valve cracks due to pressure build-up caused by
           leakage through seat on barrel #15 in pressure reduce valve 3011
           is na))
  (PREMISE
    '($EQ EX-FLOW-RETPORT-PRV3A 'NA))
  (ACTION
    '($SETQ PLUNGER14-BARREL15-PRV3A 'NA)))

(RULE066-062
  (TRANS
    '(if   excessive flow thru return port during leakage test in pressure
           reduce valve 3011 is false
     then integral relief valve cracks due to pressure build-up caused by
           leakage through seat on barrel #15 in pressure reduce valve 3011
           is false))
  (PREMISE
    '($EQ EX-FLOW-RETPORT-PRV3A 'FALSE))
  (ACTION
    '($SETQ PLUNGER14-BARREL15-PRV3A 'FALSE)))

(RULE066-063
  (TRANS
    '(if   incorrectly assembled dashpot #16 in pressure reduce valve 3011
           is na or false
     then remove and reassemble dashpot #16 in pressure reduce valve 3011
           is false))
  (PREMISE
    '(OR ($EQ DASHPOT16-PRV3A 'NA) ($EQ DASHPOT16-PRV3A 'FALSE)))
  (ACTION
    '($SETQ R-DASHPOT16-PRV3A 'FALSE)))

(RULE066-064
  (TRANS
    '(if   incorrectly assembled dashpot #16 in pressure reduce valve 3011
           is true
     then remove and reassemble dashpot #16 in pressure reduce  valve
           3011 is true))
  (PREMISE
    '($EQ DASHPOT16-PRV3A 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "REMOVE AND REASSEMBLE DASHPOT #16 in pressure reducing"
            'CR
            "valve 3A011 in flight control hydraulic system"
            'CR
            "due to incorrectly assembled dashpot"
            'CR
            "*****************************************************************"
            'CR)
     ($SETQ R-DASHPOT16-PRV3A 'TRUE))))
```

```
(RULE066-065
  (TRANS
    '(if   excessive flow thru return port during leakage test in pressure
           reduce valve 3011 is na
     then incorrectly assembled dashpot #16 in pressure reduce valve 3011
           is na))
  (PREMISE
    '($EQ EX-FLOW-RETPORT-PRV3A 'NA))
  (ACTION
    '($SETQ DASHPOT16-PRV3A 'NA)))

(RULE066-066
  (TRANS
    '(if   excessive flow thru return port during leakage test in pressure
           reduce valve 3011 is false
     then incorrectly assembled dashpot #16 in pressure reduce valve 3011
           is false))
  (PREMISE
    '($EQ EX-FLOW-RETPORT-PRV3A 'FALSE))
  (ACTION
    '($SETQ DASHPOT16-PRV3A 'FALSE)))

(RULE066-067
  (TRANS
    '(if   damaged ball seat #19 in pressure reduce valve 3011 is na or
           false
     then reseat or replace ball seat #19 in pressure reduce valve 3011
           is false))
  (PREMISE
    '(OR ($EQ BALL-SEAT19-PRV3A 'NA) ($EQ BALL-SEAT19-PRV3A 'FALSE)))
  (ACTION
    '($SETQ R-BALL-SEAT19-PRV3A 'FALSE)))

(RULE066-068
  (TRANS
    '(if   damaged ball seat #19 in pressure reduce valve 3011 is true
     then reseat or replace ball seat #19 in pressure reduce valve
           3011 is true))
  (PREMISE
    '($EQ BALL-SEAT19-PRV3A 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "RESEAT OR REPLACE BALL SEAT #19 in pressure reducing"
            'CR
            "valve 3A011 in flight control hydraulic system"
            'CR
            "due to damaged ball seat"
            'CR
            "*****************************************************************"
            'CR)
     ($SETQ R-BALL-SEAT19-PRV3A 'TRUE))))

(RULE066-069
  (TRANS
    '(if   integral relief valve cracks low at correct pressure setting in
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            pressure reduce valve 3011 is na
       then damaged ball seat #19 in pressure reduce valve 3011 is na))
  (PREMISE
    '($EQ REL-VAL-LOW-PRV3A 'NA))
  (ACTION
    '($SETQ BALL-SEAT19-PRV3A 'NA)))

(RULE066-070
  (TRANS
    '(if   integral relief valve cracks low at correct pressure setting in
           pressure reduce valve 3011 is false
     then damaged ball seat #19 in pressure reduce valve 3011 is false))
  (PREMISE
    '($EQ REL-VAL-LOW-PRV3A 'FALSE))
  (ACTION
    '($SETQ BALL-SEAT19-PRV3A 'FALSE)))

(RULE066-071
  (TRANS
    '(if   pressure reducing valve 3011 is ok
     then integral relief valve cracks low at correct pressure setting in
           pressure reduce valve 3011 is false))
  (PREMISE
    '($EQ PRV3A 'OK))
  (ACTION
    '($SETQ REL-VAL-LOW-PRV3A 'FALSE)))

(RULE066-072
  (TRANS
    '(if   binding between pushrod #17 amd barrel #15 in pressure reduce
           valve 3011 is faulty is na or false
     then buff and clean pushrod #17 and barrel #15 in pressure reduce
           valve 3011 is false))
  (PREMISE
    '(OR ($EQ PUSHROD17-BARREL15-PRV3A 'NA)
         ($EQ PUSHROD17-BARREL15-PRV3A 'FALSE)))
  (ACTION
    '($SETQ BUFF-CLEAN1-PRV3A 'FALSE)))

(RULE066-073
  (TRANS
    '(if   binding between pushrod #17 amd barrel #15 in pressure reduce
           valve 3011 is faulty is true
     then buff and clean pushrod #17 and barrel #15 in pressure reduce
           valve 3011 is true))
  (PREMISE
    '($EQ PUSHROD17-BARREL15-PRV3A 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "BUFF AND CLEAN PUSHROD #17 AND BARREL #15 in pressure reducing"
            'CR
            "valve 3A011 in flight control hydraulic system due to binding"
            'CR
            "between pushrod and barrel"
            'CR
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            "*****************************************************************"
            'CR)
      ($SETQ BUFF-CLEAN1-PRV3A 'TRUE))))

(RULE066-074
  (TRANS
    '(if   integral relief valve cracks high and reseats low in pressure
           reduce valve 3011 is na
     then binding between pushrod #17 amd barrel #15 in pressure reduce
           valve 3011 is faulty is na))
  (PREMISE
    '($EQ REL-VAL-HIGH-PRV3A 'NA))
  (ACTION
    '($SETQ PUSHROD17-BARREL15-PRV3A 'NA)))

(RULE066-075
  (TRANS
    '(if   integral relief valve cracks high and reseats low in pressure
           reduce valve 3011 is false
     then binding between pushrod #17 amd barrel #15 in pressure reduce
           valve 3011 is faulty is false))
  (PREMISE
    '($EQ REL-VAL-HIGH-PRV3A 'FALSE))
  (ACTION
    '($SETQ PUSHROD17-BARREL15-PRV3A 'FALSE)))

(RULE066-076
  (TRANS
    '(if   pressure reducing valve 3011 is ok
     then integral relief valve cracks high and reseats low in pressure
           reduce valve 3011 is false))
  (PREMISE
    '($EQ PRV3A 'OK))
  (ACTION
    '($SETQ REL-VAL-HIGH-PRV3A 'FALSE)))

(RULE066-077
  (TRANS
    '(if   binding between various components is faulty is na or false in
           pressure reduce valve 3011
     then buff and clean binding between various components in pressure
           reduce valve 3011 is false))
  (PREMISE
    '(OR ($EQ BINDING-PRV3A 'NA) ($EQ BINDING-PRV3A 'FALSE)))
  (ACTION
    '($SETQ BUFF-CLEAN2-PRV3A 'FALSE)))

(RULE066-078
  (TRANS
    '(if   binding between various components is faulty is true in
           pressure reduce valve 3011
     then buff and clean binding between various components in pressure
           reduce valve 3011 is true))
  (PREMISE
    '($EQ BINDING-PRV3A 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
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                "*****************************************************************"
                'CR
                "BUFF AND CLEAN PUSHROD BINDING BETWEEN VARIOUS COMPONENTS in"
                'CR
                "pressure reduce valve 3A011 in flight control hydraulic system"
                'CR
                "due to faulty binding between various components"
                'CR
                "*****************************************************************"
                'CR)
        ($SETQ BUFF-CLEAN2-PRV3A 'TRUE))))

(RULE066-079
  (TRANS
    '(if   valve fails to reduce correctly in pressure reduce valve 3011
           is na
     then binding between various components in pressure reduce
           valve 3011 is faulty is na))
  (PREMISE
    '($EQ VAL-RED-PRV3A 'NA))
  (ACTION
    '($SETQ BINDING-PRV3A 'NA)))

(RULE066-080
  (TRANS
    '(if   valve fails to reduce correctly in pressure reduce valve 3011
           is false
     then binding between various components in pressure reduce
           valve 3011 is faulty is false))
  (PREMISE
    '($EQ VAL-RED-PRV3A 'FALSE))
  (ACTION
    '($SETQ BINDING-PRV3A 'FALSE)))

(RULE066-081
  (TRANS
    '(if   pressure reducing valve 3011 is ok
     then valve fails to reduce correctly in pressure reduce valve
           3011 is false))
  (PREMISE
    '($EQ PRV3A 'OK))
  (ACTION
    '($SETQ VAL-RED-PRV3A 'FALSE)))

(RULE066-082
  (TRANS
    '(if   incorrectly dashpot #16 in pressure reduce valve 3011 is false
           or na
     then check for free fit with plunger #14 and reassemble in pressure
           reduce valve 3011 is false))
  (PREMISE
    '(OR ($EQ DASHPOT16-PRV3A 'NA) ($EQ DASHPOT16-PRV3A 'FALSE)))
  (ACTION
    '($SETQ C-PLUNGER14-PRV3A 'FALSE)))

(RULE066-083
  (TRANS
    '(if   incorrectly dashpot #16 in pressure reduce valve 3011 is true
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        then check for free fit with plunger #14 and reassemble in pressure
             reduce valve 3011 is true))
    (PREMISE
      '($EQ DASHPOT16-PRV3A 'TRUE))
    (ACTION
      '(PROG ()
         (MSG 'CR
              "*****************************************************************"
              'CR
              "CHECK FOR FREE FIT WITH PLUNGER #14 AND REASSEMBLE in"
              'CR
              "pressure reduce valve 3A011 in flight control hydraulic system"
              'CR
              "due toincorrectly adjusted dashpot"
              'CR
              "*****************************************************************"
              'CR)
       ($SETQ C-PLUNGER14-PRV3A 'TRUE))))

  (RULE066-084
    (TRANS
      '(if   valve chatters or squeals in pressure reduce valve 3011
             is na
       then incorrectly assembled dashpot #16 in pressure reduce valve is na))
    (PREMISE
      '($EQ VAL-SQUEALS-PRV3A 'NA))
    (ACTION
      '($SETQ DASHPOT16-PRV3A 'NA)))

  (RULE066-085
    (TRANS
      '(if   valve chatters or squeals in pressure reduce valve 3011
             is false
       then incorrectly assembled dashpot #16 in pressure reduce valve is
             false))
    (PREMISE
      '($EQ VAL-SQUEALS-PRV3A 'FALSE))
    (ACTION
      '($SETQ DASHPOT16-PRV3A 'FALSE)))

  (RULE066-086
    (TRANS
      '(if   pressure reducing valve 3011 is ok
       then valve chatters or squeals in in pressure reduce valve
             3011 is false))
    (PREMISE
      '($EQ PRV3A 'OK))
    (ACTION
      '($SETQ VAL-SQUEALS-PRV3A 'FALSE)))

  (RULE066-087
    (TRANS
      '(if   incorrect assembly of packing #12 and washer #11 in pressure
             reduce valve 3011 is na or false
       then remove and reassemble packing #12 and washer #11 in pressure
             reduce valve 3011 is false))
    (PREMISE
      '(OR ($EQ PACKING12-WASHER11-PRV3A 'NA)
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          ($EQ PACKING12-WASHER11-PRV3A 'FALSE)))
    (ACTION
      '($SETQ R-PACKING12-WASHER11-PRV3A 'FALSE)))

  (RULE066-088
    (TRANS
      '(if   incorrect assembly of packing #12 and washer #11 in pressure
             reduce valve 3011 is true
       then remove and reassemble packing #12 and washer #11 in pressure
             reduce valve 3011 is true))
    (PREMISE
      '($EQ PACKING12-WASHER11-PRV3A 'TRUE))
    (ACTION
      '(PROG ()
         (MSG 'CR
              "*****************************************************************"
              'CR
              "REMOVE AND REASSEMBLE PACKING #12 AND WASHER #11 in"
              'CR
              "pressure reduce valve 3A011 in flight control hydraulic system"
              'CR
              "due to incorrect assembly of packing and washer"
              'CR
              "*****************************************************************"
              'CR)
       ($SETQ R-PACKING12-WASHER11-PRV3A 'TRUE))))

  (RULE066-089
    (TRANS
      '(if   valve chatters or squeals in pressure reduce valve 3011
             is na
       then incorrect assembly of packing #12 and washer #11 in pressure
             reduce valve 3011 is na))
    (PREMISE
      '($EQ VAL-SQUEALS-PRV3A 'NA))
    (ACTION
      '($SETQ PACKING12-WASHER11-PRV3A 'NA)))

  (RULE066-090
    (TRANS
      '(if   valve chatters or squeals in pressure reduce valve 3011
             is false
       then incorrect assembly of packing #12 and washer #11 in pressure
             reduce valve 3011 is false))
    (PREMISE
      '($EQ VAL-SQUEALS-PRV3A 'FALSE))
    (ACTION
      '($SETQ PACKING12-WASHER11-PRV3A 'FALSE)))

  (RULE066-091
    (TRANS
      '(if   tight fitting #8 in pressure reduce valve 3011 is na or false
       then unscrew and retorque fitting #8 to 250 pound-inches in pressure
             reduce valve 3011 is false))
    (PREMISE
      '(OR ($EQ FITTING8-PRV3A 'NA)
           ($EQ FITTING8-PRV3A 'FALSE)))
    (ACTION
```

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    '($SETQ R-FITTING8-PRV3A 'FALSE)))

(RULE066-092
  (TRANS
    '(if   tight fitting #8 in pressure reduce valve 3011 is true
     then unscrew and retorque fitting #8 to 250 pound-inches in pressure
          reduce valve 3011 is true))
  (PREMISE
    '($EQ FITTING8-PRV3A 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "UNSCREW AND RETORQUE FITTING #8 TO 250 POUND-INCHES in"
            'CR
            "pressure reduce valve 3A011 in flight control hydraulic system"
            'CR
            "due to tight fitting"
            'CR
            "*****************************************************************"
            'CR)
     ($SETQ R-FITTING8-PRV3A 'TRUE))))

(RULE066-093
  (TRANS
    '(if   valve chatters or squeals in pressure reduce valve 3011
           is na
     then tight fitting #8 in pressure reduce valve 3011 is na))
  (PREMISE
    '($EQ VAL-SQUEALS-PRV3A 'NA))
  (ACTION
    '($SETQ FITTING8-PRV3A 'NA)))

(RULE066-094
  (TRANS
    '(if   valve chatters or squeals in pressure reduce valve 3011
           is false
     then tight fitting #8 in pressure reduce valve 3011 is true))
  (PREMISE
    '($EQ VAL-SQUEALS-PRV3A 'FALSE))
  (ACTION
    '($SETQ FITTING8-PRV3A 'FALSE)))

(RULE066-095
  (TRANS
    '(if  damaged packing #7 in pressure filter 13, 14 na or false
     then remove bowl and replace packing in pressure filter 13, 14 is
          false))
  (PREMISE
    '(OR ($EQ PACKING7-PF1314 'NA)
         ($EQ PACKING7-PF1314 'FALSE)))
  (ACTION
    '($SETQ R-BOWL-PACKING-PF1314 'FALSE)))

(RULE066-096
  (TRANS
    '(if   damaged packing #7 in pressure filter 13, 14 is true
```

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       then remove bowl and replace packing in pressure filter 13, 14 is
            true))
    (PREMISE
      '($EQ PACKING7-PF1314 'TRUE))
    (ACTION
      '(PROG ()
        (MSG 'CR
             "*****************************************************************"
             'CR
             "REMOVE BOWL AND REPLACE PACKING in pressure filter 13, 14"
             'CR
             "in flight control hydraulic system due to damaged packing"
             'CR
             "*****************************************************************"
             'CR)
       ($SETQ R-BOWL-PACKING-PF1314 'TRUE))))

  (RULE066-097
    (TRANS
      '(if   leak between bowl and assembly in pressure filter 13, 14 is na
       then damaged packing in pressure filter 13, 14 is na))
    (PREMISE
      '($EQ LBOHEA-PF1314 'NA))
    (ACTION
      '($SETQ PACKING7-PF1314 'NA)))

  (RULE066-098
    (TRANS
      '(if   leak between bowl and assembly in pressure filter 13, 14 is false
       then damaged packing in pressure filter 13, 14 is true))
    (PREMISE
      '($EQ LBOHEA-PF1314 'FALSE))
    (ACTION
      '($SETQ PACKING7-PF1314 'FALSE)))

  (RULE066-099
    (TRANS
      '(if   pressure filter 13, 14 is ok in flight control hydraulic
             system
       then leak between bowl and head assembly is false))
    (PREMISE
      '($EQ PF1314 'OK))
    (ACTION
      '($SETQ LBOHEA-PF1314 'FALSE)))

  (RULE066-100
    (TRANS
      '(if   pressure filter is ok in flight control hydraulic system
       then pressure filter 13, 14 is ok))
    (PREMISE
      '($EQ PF 'OK))
    (ACTION
      '($SETQ PF1314 'OK)))

  (RULE066-101
    (TRANS
      '(if   damaged sliding sleeve #40 in pressure filter 13, 14 na or false
       then replace spool assembly #43 in pressure filter 13, 14 is false))
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    (PREMISE
      '(OR ($EQ DAMSLSL40-PF1314 'NA)
           ($EQ DAMSLSL40-PF1314 'FALSE)))
    (ACTION
      '($SETQ R-SPOOL43-PF1314 'FALSE)))

  (RULE066-102
    (TRANS
      '(if   damaged sliding sleeve #40 in pressure filter 13, 14 true
       then replace spool assembly #43 in pressure filter 13, 14 is true))
    (PREMISE
      '($EQ DAMSLSL40-PF1314 'TRUE))
    (ACTION
      '(PROG ()
         (MSG 'CR
              "*****************************************************************"
              'CR
              "REPLACE SPOOL ASSEMBLY #43 in pressure filter 13, 14"
              'CR
              "in flight control hydraulic system due to damaged sliding sleeve"
              'CR
              "*****************************************************************"
              'CR)
       ($SETQ R-SPOOL43-PF1314 'TRUE))))

  (RULE066-103
    (TRANS
      '(if   leak around pressure differential indicator and leak at bleed
             plug in pressure filter 13, 14 is na
       then damaged sliding sleeve #40 in pressure filter 13, 14 is na))
    (PREMISE
      '(AND ($EQ LPDIFFIND-PF1314 'NA) ($EQ LADPLUG-PF1314 'NA)))
    (ACTION
      '($SETQ DAMSLSL40-PF1314 'NA)))

  (RULE066-104
    (TRANS
      '(if   leak around pressure differential indicator and leak at bleed
             plug in pressure filter 13, 14 is false
       then damaged sliding sleeve #40 in pressure filter 13, 14 is false))
    (PREMISE
      '(AND ($EQ LPDIFFIND-PF1314 'FALSE) ($EQ LADPLUG-PF1314 'FALSE)))
    (ACTION
      '($SETQ DAMSLSL40-PF1314 'FALSE)))

  (RULE066-105
    (TRANS
      '(if   pressure filter 13, 14 is ok in flight control hydraulic
             system
       then leak around pressure differential indicator in pressure filter
             13, 14 is false))
    (PREMISE
      '($EQ PF1314 'OK))
    (ACTION
      '($SETQ LPDIFFIND-PF1314 'FALSE)))

  (RULE066-106
    (TRANS
```

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      '(if   pressure filter 13, 14 is ok in flight control hydraulic system
        then leak at adjusting plug in pressure filter 13, 14 is false))
    (PREMISE
      '($EQ PF1314 'OK))
    (ACTION
      '($SETQ LADPLUG-PF1314 'FALSE)))

  (RULE066-107
    (TRANS
      '(if   incorrectly adjusted pressure differential drop in pressure
             filter 13, 14 is na or false
        then correct adjustment in pressure filter 13, 14 is false))
    (PREMISE
      '(OR ($EQ INADPDIFF-PF1314 'NA)
           ($EQ INADPDIFF-PF1314 'FALSE)))
    (ACTION
      '($SETQ C-ADJUSTMENT-PF1314 'FALSE)))

  (RULE066-108
    (TRANS
      '(if   incorrectly adjusted pressure differential drop in pressure
             filter 13, 14 is true
        then correct adjustment in pressure filter 13, 14 is true))
    (PREMISE
      '($EQ INADPDIFF-PF1314 'TRUE))
    (ACTION
      '(PROG ()
        (MSG 'CR
             "*****************************************************************"
             'CR
             "CORRECT ADJUSTMENT in pressure filter 13, 14 in flight control"
             'CR
             "hydraulic system due to incorrectly adjusted pressure different-"
             'CR
             "ial drop"
             'CR
             "*****************************************************************"
             'CR)
       ($SETQ C-ADJUSTMENT-PF1314 'TRUE))))

  (RULE066-109
    (TRANS
      '(if   pressure differential indicator extended; filter element clean
             in pressure filter 13, 14 is na
        then incorrectly adjusted pressure differential drop in pressure
             filter 13, 14 is na))
    (PREMISE
      '($EQ PDIFFINDE-PF1314 'NA))
    (ACTION
      '($SETQ INADPDIFF-PF1314 'NA)))

  (RULE066-110
    (TRANS
      '(if   pressure differential indicator extended; filter element clean
             in pressure filter 13, 14 is false
        then incorrectly adjusted pressure differential drop in pressure
             filter 13, 14 is false))
    (PREMISE
```

```
    '($EQ PDIFFINDE-PF1314 'FALSE))
  (ACTION
    '($SETQ INADPDIFF-PF1314 'FALSE)))

(RULE066-111
  (TRANS
    '(if   pressure filter 13, 14 is ok in flight control hydraulic
           system
     then pressure differential indicator extended; filter element clean
           in pressure filter 13, 14 is false))
  (PREMISE
    '($EQ PF1314 'OK))
  (ACTION
    '($SETQ PDIFFINDE-PF1314 'FALSE)))

(RULE066-112
  (TRANS
    '(if   damaged packing #14 in pressure filter 13, 14 is na or false
     then remove plug and replace packing in filter 13, 14 is false))
  (PREMISE
    '(OR ($EQ PACKING14-PF1314 'NA)
         ($EQ PACKING14-PF1314 'FALSE)))
  (ACTION
    '($SETQ R-PLUG-PACKING14-PF1314 'FALSE)))

(RULE066-113
  (TRANS
    '(if   damaged packing #14 in pressure filter 13, 14 is true
     then remove plug and replace packing in filter 13, 14 is true))
  (PREMISE
    '($EQ PACKING14-PF1314 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "REMOVE PLUG AND REPLACE PACKING #14 in pressure filter 13, 14"
            'CR
            "in flight control hydraulic system due to damaged packing"
            'CR
            "*****************************************************************"
            'CR)
     ($SETQ R-PLUG-PACKING14-PF1314 'TRUE))))

(RULE066-114
  (TRANS
    '(if   leak at bleed plug in pressure filter 13, 14 is na
     then damaged packing #14 in pressure filter 13, 14 is na))
  (PREMISE
    '($EQ LBLEPL-PF1314 'NA))
  (ACTION
    '($SETQ PACKING14-PF1314 'NA)))

(RULE066-115
  (TRANS
    '(if   leak at bleed plug in pressure filter 13, 14 is false
     then damaged packing #14 in pressure filter 13, 14 is false))
  (PREMISE
```

```
    '($EQ LBLEPL-PF1314 'FALSE))
  (ACTION
    '($SETQ PACKING14-PF1314 'FALSE)))

(RULE066-116
  (TRANS
    '(if   pressure filter 13, 14 is ok in flight control hydraulic
           system
     then leak at bleed plug in pressure filter 13, 14 is false))
  (PREMISE
    '($EQ PF1314 'OK))
  (ACTION
    '($SETQ LBLEPL-PF1314 'FALSE)))

(RULE066-117
  (TRANS
    '(if   damaged packing #3 in pressure filter 15, 16 is na or false
     then replace packing #3 in pressure filter 15, 16 is false))
  (PREMISE
    '(OR ($EQ PACKING3-PF1516 'NA)
         ($EQ PACKING3-PF1516 'FALSE)))
  (ACTION
    '($SETQ R-PACKING3-PF1516 'FALSE)))

(RULE066-118
  (TRANS
    '(if   damaged packing #3 in pressure filter 15, 16 is true
     then replace packing #3 in pressure filter 15, 16 is true))
  (PREMISE
    '($EQ PACKING3-PF1516 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "REPLACE PACKING #3 in pressure filter 15, 16"
            'CR
            "in flight control hydraulic system due to damaged packing"
            'CR
            "*****************************************************************"
            'CR)
     ($SETQ R-PACKING3-PF1516 'TRUE))))

(RULE066-119
  (TRANS
    '(if   leak between bowl and head in pressure filter 15, 16 is na
     then damaged packing #3 in pressure filter 15, 16 is na))
  (PREMISE
    '($EQ LBOHEA-PF1516 'NA))
  (ACTION
    '($SETQ PACKING3-PF1516 'NA)))

(RULE066-120
  (TRANS
    '(if   leak between bowl and head in pressure filter 15, 16 is false
     then damaged packing #3 in pressure filter 15, 16 is false))
  (PREMISE
    '($EQ LBOHEA-PF1516 'FALSE))
```

```
    (ACTION
      '($SETQ PACKING3-PF1516 'FALSE)))

  (RULE066-121
    (TRANS
      '(if   pressure filter 15, 16 is ok in flight control hydraulic
             system
       then leak between bowl and head in pressure filter 15, 16 is false))
    (PREMISE
      '($EQ PF1516 'OK))
    (ACTION
      '($SETQ LBOHEA-PF1516 'FALSE)))

  (RULE066-122
    (TRANS
      '(if   pressure filter is ok in flight control hydraulic system
       then pressure filter 15, 16 is ok))
    (PREMISE
      '($EQ PF 'OK))
    (ACTION
      '($SETQ PF1516 'OK)))

  (RULE066-123
    (TRANS
      '(if   loose indicator #15 in pressure filter 15, 16 is na or false
       then tighten indicator in pressure filter 15, 16 is false))
    (PREMISE
      '(OR ($EQ LOOIND15-PF1516 'NA)
           ($EQ LOOIND15-PF1516 'FALSE)))
    (ACTION
      '($SETQ T-INDICATOR15-PF1516 'FALSE)))

  (RULE066-124
    (TRANS
      '(if   loose indicator #15 in pressure filter 15, 16 is true
       then tighten indicator in pressure filter 15, 16 is true))
    (PREMISE
      '($EQ LOOIND15-PF1516 'TRUE))
    (ACTION
      '(PROG ()
         (MSG 'CR
              "**************************************************************"
              'CR
              "TIGHTEN INDICATOR #15 in pressure filter 15, 16"
              'CR
              "in flight control hydraulic system due to loosened indicator"
              'CR
              "**************************************************************"
              'CR)
       ($SETQ T-INDICATOR15-PF1516 'TRUE))))

  (RULE066-125
    (TRANS
      '(if   leakage between head and indicator in pressure filter 15, 16 is na
       then loose indicator #15 in pressure filter 15, 16 is na))
    (PREMISE
      '($EQ LHEIND-PF1516 'NA))
    (ACTION
```

```
    '($SETQ LOOIND15-PF1516 'NA)))

(RULE066-126
  (TRANS
    '(if   leakage between head and indicator in pressure filter 15, 16
           is false
     then loose indicator #15 in pressure filter 15, 16 is false))
  (PREMISE
    '($EQ LHEIND-PF1516 'FALSE))
  (ACTION
    '($SETQ LOOIND15-PF1516 'FALSE)))

(RULE066-127
  (TRANS
    '(if   pressure filter 15, 16 is ok in flight control hydraulic
           system
     then leakage between head and indicator in pressure filter 15, 16
           is false))
  (PREMISE
    '($EQ PF1516 'OK))
  (ACTION
    '($SETQ LHEIND-PF1516 'FALSE)))

(RULE066-128
  (TRANS
    '(if   damaged packing #8 in pressure filter 15, 16 is na or false
     then replace packing #8 in pressure filter 15, 16 is false))
  (PREMISE
    '(OR ($EQ PACKING8-PF1516 'NA)
         ($EQ PACKING8-PF1516 'FALSE)))
  (ACTION
    '($SETQ R-PACKING8-PF1516 'FALSE)))

(RULE066-129
  (TRANS
    '(if   damaged packing #8 in pressure filter 15, 16 is true
     then replace packing #8 in pressure filter 15, 16 is true))
  (PREMISE
    '($EQ PACKING8-PF1516 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "REPLACE PACKING #8 in pressure filter 15, 16"
            'CR
            "in flight control hydraulic system due to damaged packing"
            'CR
            "*****************************************************************"
            'CR)
     ($SETQ R-PACKING8-PF1516 'TRUE))))

(RULE066-130
  (TRANS
    '(if   low output, excessive pressure drop in pressure filter 15, 16
           is na
     then damaged packing #8 in pressure filter 15, 16 is na))
  (PREMISE
```

```
    '($EQ EXPRD-PF1516 'NA))
  (ACTION
    '($SETQ PACKING8-PF1516 'NA)))

(RULE066-131
  (TRANS
    '(if   low output, excessive pressure drop in pressure filter 15, 16
           is false
     then damaged packing #8 in pressure filter 15, 16 is false))
  (PREMISE
    '($EQ EXPRD-PF1516 'FALSE))
  (ACTION
    '($SETQ PACKING8-PF1516 'FALSE)))

(RULE066-132
  (TRANS
    '(if   pressure filter 15, 16 is ok in flight control hydraulic
           system
     then low output, excessive pressure drop in pressure filter 15, 16
           is false))
  (PREMISE
    '($EQ PF1516 'OK))
  (ACTION
    '($SETQ EXPRD-PF1516 'FALSE)))

(RULE066-133
  (TRANS
    '(if   clogged or dirty element #5 in presure filter 15, 16 is na or false
     then clean or replace element in pressure filter 15, 16 is false))
  (PREMISE
    '(OR ($EQ CLGD-ELEMENT5-PF1516 'NA)
         ($EQ CLGD-ELEMENT5-PF1516 'FALSE)))
  (ACTION
    '($SETQ C-R-ELEMENT-PF1516 'FALSE)))

(RULE066-134
  (TRANS
    '(if   clogged or dirty element #5 in pressure filter 15, 16 is true
     then clean or replace element in pressure filter 15, 16 is true))
  (PREMISE
    '($EQ CLGD-ELEMENT5-PF1516 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "CLEAN OR REPLACE ELEMENT #5 in pressure filter 15, 16 in flight"
            'CR
            "control hydraulic system due to clogged or dirty element"
            'CR
            "*****************************************************************"
            'CR)
     ($SETQ C-R-ELEMENT-PF1516 'TRUE))))

(RULE066-135
  (TRANS
    '(if   low output, excessive pressure drop and excessive leakage between
           shutoff valve and head in pressure filter 15, 16 are na
```

```
      then clogged or dirty element #5 in pressure filter 15, 16 is na))
    (PREMISE
      '(AND ($EQ EXPRD-PF1516 'NA) ($EQ LSVH-PF1516 'NA)))
    (ACTION
      '($SETQ CLGD-ELEMENT5-PF1516 'NA)))

  (RULE066-136
    (TRANS
      '(if   low output, excessive pressure drop and excessive leakage betwee
             shutoff valve and head in pressure filter 15, 16 are false
       then clogged or dirty element #5 in pressure filter 15, 16 is false))
    (PREMISE
      '(AND ($EQ EXPRD-PF1516 'FALSE) ($EQ LSVH-PF1516 'FALSE)))
    (ACTION
      '($SETQ CLGD-ELEMENT5-PF1516 'FALSE)))

  (RULE066-137
    (TRANS
      '(if   pressure filter 15, 16 is ok in flight control hydraulic
             system
       then excessive leakage between shutoff valve and head in pressure
             filter 15, 16 is false))
    (PREMISE
      '($EQ PF1516 'OK))
    (ACTION
      '($SETQ LSVH-PF1516 'FALSE)))

  (RULE066-138
    (TRANS
      '(if   shutoff valve #10 not properly opened in pressure filter 15, 16
             is na or false
       then replace defective part of shutoff valve in pressure filter 15, 16
             is false))
    (PREMISE
      '(OR ($EQ SHOVAL10-PF1516 'NA)
           ($EQ SHOVAL10-PF1516 'FALSE)))
    (ACTION
      '($SETQ R-PART10-PF1516 'FALSE)))

  (RULE066-139
    (TRANS
      '(if   shutoff valve #10 not properly opened in pressure filter 15, 16
             is true
       then replace defective part of shutoff valve in pressure filter 15, 16
             is true))
    (PREMISE
      '($EQ SHOVAL10-PF1516 'TRUE))
    (ACTION
      '(PROG ()
         (MSG 'CR
              "*****************************************************************"
              'CR
              "REPLACE DEFECTIVE PART OF SHUTOFF VALVE in pressure filter"
              'CR
              "15, 16 in flight control hydraulic system due to not properly"
              'CR
              "opened shutoff valve"
              'CR
```

```
            "*****************************************************************"
            'CR)
      ($SETQ R-PART10-PF1516 'TRUE))))

(RULE066-140
  (TRANS
    '(if   low output, excessive pressure drop in pressure filter 15, 16
           is na
     then shutoff valve #10 not properly opened in pressure filter 15, 16
           is na))
  (PREMISE
    '($EQ EXPRD-PF1516 'NA))
  (ACTION
    '($SETQ SHOVAL10-PF1516 'NA)))

(RULE066-141
  (TRANS
    '(if   low output, excessive pressure drop in pressure filter 15, 16
           is false
     then shutoff valve #10 not properly opened in pressure filter 15, 16
           is false))
  (PREMISE
    '($EQ EXPRD-PF1516 'FALSE))
  (ACTION
    '($SETQ SHOVAL10-PF1516 'FALSE)))

(RULE066-142
  (TRANS
    '(if   damaged sealing surface on head in pressure filter 15, 16
           is na or false
     then replace filter assembly in pressure filter 15, 16
           is false))
  (PREMISE
    '(OR ($EQ DAM-SESURFH-PF1516 'NA)
         ($EQ DAM-SESURFH-PF1516 'FALSE)))
  (ACTION
    '($SETQ R-FIL-ASSEMBLY-PF1516 'FALSE)))

(RULE066-143
  (TRANS
    '(if   damaged sealing surface on head in pressure filter 15, 16
           is true
     then replace filter assembly in pressure filter 15, 16
           is true))
  (PREMISE
    '($EQ DAM-SESURFH-PF1516 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "REPLACE FILTER ASSEMBLY in pressure filter 15, 16 in flight"
            'CR
            "control hydraulic system due to damaged sealing surface on head"
            'CR
            "*****************************************************************"
            'CR)
      ($SETQ R-FIL-ASSEMBLY-PF1516 'TRUE))))
```

```
(RULE066-144
  (TRANS
    '(if   excessive leakage between shutoff valve and head in pressure
           filter is na
     then damaged sealing surface on head in pressure filter 15, 16
           is na))
  (PREMISE
    '($EQ LSVH-PF1516 'NA))
  (ACTION
    '($SETQ DAM-SESURFH-PF1516 'NA)))

(RULE066-145
  (TRANS
    '(if   excessive leakage between shutoff valve and head in pressure
           filter is false
     then damaged sealing surface on head in pressure filter 15, 16
           is false))
  (PREMISE
    '($EQ LSVH-PF1516 'FALSE))
  (ACTION
    '($SETQ DAM-SESURFH-PF1516 'FALSE)))

(RULE066-146
  (TRANS
    '(if   loose indicator #15 in pressure filter 15, 16 is na or false
     then replace indicator #15 in pressure filter 15, 16 is false))
  (PREMISE
    '(OR ($EQ LOOIND15-PF1516 'NA)
         ($EQ LOOIND15-PF1516 'FALSE)))
  (ACTION
    '($SETQ R-INDICATOR15-PF1516 'FALSE)))

(RULE066-147
  (TRANS
    '(if   loose indicator #15 in pressure filter 15, 16 is true
     then replace indicator #15 in pressure filter 15, 16 is true))
  (PREMISE
    '($EQ LOOIND15-PF1516 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "REPLACE INDICATOR #15 in pressure filter 15, 16 in flight"
            'CR
            "control hydraulic system due to loose indicator"
            'CR
            "*****************************************************************"
            'CR)
     ($SETQ R-INDICATOR15-PF1516 'TRUE))))

(RULE066-148
  (TRANS
    '(if   indicator #15 does not actuate at preset pressure in pressure
           filter 15, 16 is na
     then loose indicator #15 in pressure filter 15, 16 is na))
  (PREMISE
```

```
    '($EQ INDPP15-PF1516 'NA))
  (ACTION
    '($SETQ LOOIND15-PF1516 'NA)))

(RULE066-149
  (TRANS
    '(if   indicator #15 does not actuate at preset pressure in pressure
           filter 15, 16 is false
     then loose indicator #15 in pressure filter 15, 16 is false))
  (PREMISE
    '($EQ INDPP15-PF1516 'FALSE))
  (ACTION
    '($SETQ LOOIND15-PF1516 'FALSE)))

(RULE066-150
  (TRANS
    '(if   pressure filter 15, 16 is ok
     then indicator #15 does not actuate at preset pressure in pressure
           filter 15, 16 is false))
  (PREMISE
    '($EQ PF1516 'OK))
  (ACTION
    '($SETQ INDPP15-PF1516 'FALSE)))

(RULE067
  (TRANS
    '(if   trapped air in system is not applicable or false
     then  do not loosen flexible supply line to flight control pump))
  (PREMISE
    '(OR ($EQ TA-IN-SYS 'NA) ($EQ TA-IN-SYS 'FALSE)))
  (ACTION
    '($SETQ L-FS-L 'NO)))

(RULE068
  (TRANS
    '(if   trapped air in system is true
     then  do loosen flexible supply line to flight control pump))
  (PREMISE
    '($EQ TA-IN-SYS 'TRUE))
  (ACTION
    '(PROG ()
       (MSG 'CR
            "*****************************************************************"
            'CR
            "LOOSEN FLEXIBLE SUPPLY LINE to flight control pump"
            'CR
            "due to trapped air in system"
            'CR
            "*****************************************************************"
            'CR)
     ($SETQ L-FS-L 'YES))))

(RULE069
  (TRANS
    '(if   trapped air in system is not applicable or false
     then  do not loosen line to flight boost accumulator))
  (PREMISE
    '(OR ($EQ TA-IN-SYS 'NA) ($EQ TA-IN-SYS 'FALSE)))
```

```
    (ACTION
      '($SETQ L-FBA-L 'NO)))

  (RULE070
    (TRANS
      '(if   trapped air in system is true
       then  do loosen line to flight boost accumulator))
    (PREMISE
      '($EQ TA-IN-SYS 'TRUE))
    (ACTION
      '(PROG ()
         (MSG 'CR
              "*****************************************************************"
              'CR
              "LOOSEN LINE TO FLIGHT BOOST ACCUMULATOR"
              'CR
              "due to trapped air in system"
              'CR
              "*****************************************************************"
              'CR)
       ($SETQ L-FBA-L 'YES))))

  (RULE071
    (TRANS
      '(if   pressure is zero is false
       then  trapped air at system is not applicable))
    (PREMISE
      '($EQ PZ 'FALSE))
    (ACTION
      '($SETQ TA-IN-SYS 'NA))))

~ #####   KNOWLEDGE BASE INITIALIZATION   ############################



(FIND-PARAMETER-RULE-RELATIONS *PARAMETER-GROUP* *RULE-GROUP*)
(INITIALIZE-KB *PARAMETER-GROUP* *RULE-GROUP*)
(HELP)
```

END

DTIC

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